Cluster 4 – Digital, Industry and Space

Preliminary list of ideas for discussion regarding potential topics for the Work Programme 2023-24, v 31/01/22

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In particular, draft topics do not represent any commitment and do not necessarily include all aspects of the scope or address all cross-cutting aspects, such as international cooperation, social sciences and humanities, social innovation, gender, standardisation, synergies etc..

Contents

1. Destination: Climate neutral, Circular and Digitised Production

Global leadership in clean, climate-neutral and resilient industrial value chains, circular economy and climate-neutral and human-centric digital systems and infrastructures (networks, data centres), through innovative production and manufacturing processes and their digitisation, new business models, sustainable-by-design advanced materials and technologies enabling the switch to decarbonisation in all major emitting industrial sectors, including green digital technologies.

1.1 Manufacturing Industry

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-01: Advanced manufacturing of bio-based technology (Made in Europe) (IA)

Expected outcome:

- European bio-based manufacturing industries are developed and reinforced
- Manufacturing industry gains access to production technologies aiming at transforming bio-based materials and bio-technologies into functional products.
- Manufacturing industry benefits from technological advances in the integration of bio-intelligent principles.

Scope: Biological transformation of industry is a pioneering frontier that European Industries can harness to achieve their Green Deal Objectives while advancing production efficiency. This transformation can also aid in reducing the carbon footprint of our industries and improve its circularity while contributing to the competitiveness and digitalisation of European Industries.

Proposals need to demonstrate the upscaled production of bio-based materials products in at least three different manufacturing value chains. In addition, sustainable business models need to be developed for production and recycling of bio-based materials products.

Proposals should address advance manufacturing techniques (e.g. additive manufacturing, extrusion, moulding etc..) to process bio-materials and bio-technology components for upscaled production.

Proposals should address sectors whose raw materials could be substituted by bio-based materials, creating regenerative business models.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should contribute to the concept of a materials acceleration platform: an ecosystem of tools and capabilities including materials modelling, characterization and data documentation, ontologies, which are orchestrated to accelerate the design, development and application of chemicals, materials and related processes/manufacturing.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Additionally, a strategy for skills development should be presented, associating social partners where relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnership Made in Europe.

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-02: High-precision, flexible and sustainable production of complex products – including with the use of lasers (Made in Europe and Photonics Partnerships) (IA)

Expected Outcome: Manufacturing industry should benefit from the following outcomes:

- High-precision manufacturing of products with complex geometries, structure and materials;
- Highly resilient and flexible production lines, enabling highly individualised products down to lot size one, across a wide range of consumer markets.
- Significant reductions in the use of non-renewable materials, waste, defects and energy consumption.
- Fostering the competitiveness of the EU manufacturing industry, in general but especially in the field of laser machine tools and within the laser markets.

Scope: Products are increasingly complex, e.g. geometries, structures, embedded and structural electronics, micro-features, advanced multi-materials. Moreover, newer constraints are coming from new requirements of sustainability in production processes (resource and energy efficiency).

To maintain technological autonomy and to enable the viable and sustainable manufacturing of high-tech products, innovative advanced manufacturing processes should be developed. Digital models make development, production, and operation of complex products manageable.

Proposals should address the following:

- Advancement of, and demonstration of significant quality improvement in, smart production technologies to manufacture complex products such as additive manufacturing and laser-based manufacturing, intelligent and autonomous handling, shaping, joining, coating, and assembly technologies;

- Functional printing to manufacture complex products;

OR

- Advancement in laser-based manufacturing in combination with other processing technologies, for example mechanical machining, thin film coating, etching and electrochemical machining, to achieve new product functionalities or highly individualised production. This includes new and advanced methods and schemes of adapting laser beams and processes to provide a highly precise distribution of photons at the right place and at the right time.

In both cases, process development will be required in order to demonstrate and validate the benefits the technologies in flexible and individualized manufacturing processes, minimising waste, defects and energy consumption. The focus is [can be] on addressing demands in healthcare, transport, energy generation and environmental areas.

Proposals could also consider the following:

- Use of novel sustainable and smart materials to achieve same or higher technical features in products while reducing environmental impact;

- Parallel product and manufacturing engineering, developing cyber physical systems, e.g. digital twins, to manage complex production using data spaces across the whole value chain.

- Multiscale physics-based models and machine learning/AI methodologies to improve prediction capacity/optimisation in manufacturing, remanufacturing and reuse.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Additionally, a strategy for skills development should be presented, associating social partners where relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnerships Made in Europe and Photonics.

To ensure a balanced portfolio coverage, proposals will be selected not only in order of ranking, but also on the basis of the two highest ranked for each type of solution (with and without the use of lasers).

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-03: Sustainable decentralised manufacturing close to the consumer (Made in Europe Partnership) (IA)

Expected outcomes: Manufacturing industry, as well as consumers and wider communities, should benefit from the following outcomes:

- Designing and demonstrating symbiotic and sustainable factories that support a decentralised manufacturing vision close to the consumer – this will in turn bring benefits in terms of flexibility, resilience, urban transformation and minimisation of transport costs;
- Developing concepts such as public shared spaces and a public facade that offer increased value for the larger community, inspired by the New European Bauhaus [reference, details];
- Human-centric approaches to enhance wider engagement and creativity, with appropriate contributions from Social Sciences and Humanities (SSH).
- Reduction of noise, waste and pollution due to industrial activities;
- Significant improvements in small-series, customised production costs in decentralised environments as compared to traditional economies-of-scale production sites, thereby contributing significantly to a sustainable manufacturing industry.
- Improved access to flexible production capabilities in decentralised environments, especially for SMEs.

Scope:

Factories are typically located outside cities because of their environmental impact and the disruption of the urban landscape. However, with population growth and urbanization trends, this approach has created massive traffic flow of workers from cities to production locations, thus increasing the pollution generated by mobility and reducing people's quality of life due to traffic congestion and longer commuting time.

Decentralised, local manufacturing is characterised by small, versatile factories, close to customers, and to highly qualified workers, where various types of customised products are produced in small series for the cost price of mass-produced products.

New technologies allow manufacturing activities to be quieter and more discrete. They offer the possibility of implementing manufacturing processes in the city, limiting time to reach the

job place for workers, bringing production closer to customers and consumers, promoting a more efficient use of materials and urban resilience.

The challenge is to better understand customer needs, to significantly reduce quotation-delivery lead time, to reduce transaction costs for small series, to better link customer needs, digital design, simulation, and manufacturing, and to smoothly collaborate with different actors. Latest developments of the industrial internet, big data technologies and blockchain enable or promise easier connected digital value chains. It also requires flexible production equipment, such as robots, CNC systems, 3D printers, and fast change-over times.

Research activities should cover:

- Green and digital technologies that allow production in urban contexts with lower environmental impact, noise, waste, energy and space consumption.
- Approaches for the circular economy by closing the material and energy cycles in cities and transforming waste streams into productive resources.
- Activities for developing skills, include unemployed workforce, engage citizens and other stakeholders.
- Planning integration of the factories in their social and urban environment such as urban transport, parking, shopping and entertainment centres and support to families.
- digitally-enabled solutions that support the localised/urban manufacturing vision. Possible technology development includes the adoption of artificial intelligence and smart data approaches for local/urban production to control and optimise distributed manufacturing and logistic processes; Internet of Things solutions and big data analysis to reach zero-defect manufacturing processes and zero-surprises predictive maintenance; distributed ledger technologies to reduce transaction costs.

Developed technologies should be demonstrated in at least two complementary use cases.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should contribute to the concept of a materials acceleration platform: an ecosystem of tools and capabilities including materials modelling, characterization and data documentation, ontologies, which are orchestrated to accelerate the design, development and application of chemicals, materials and related processes/manufacturing.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

A human-centric approach should be integrated, with appropriate contributions from Social Sciences and Humanities (SSH); as part of this, a strategy for skills development should be included, associating social partners where relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnership Made in Europe.

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-04: Systems integration and resilient supply chains in manufacturing (Made in Europe Partnership) (IA)

Expected Outcome: Manufacturing industry should benefit from the following outcomes:

- Suitably scaled green and digital technologies that support systems integration in industrial ecosystems
- More resilient and integrated manufacturing systems and supply chains
- Shortened supply chain times

Scope:
Proposal should improve supply chain management across industries, moving away from Just-in-time manufacturing to a resilient supply chains systems able to accommodate for productions shocks.

- Demonstrate technologies in at least three user cases
- Develop symbiosis in a variety of value chains (including for example biotech, pharmaceutical, food industries etc..) contributing to circular economy and overall decarbonisation of European industries.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should contribute to the concept of a materials acceleration platform: an ecosystem of tools and capabilities including materials modelling, characterization and data documentation, ontologies, which are orchestrated to accelerate the design, development and application of chemicals, materials and related processes/manufacturing.

Projects should contribute to standardisation of relevant technologies.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnership Made in Europe.

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-05: [Digital] technologies to support circularity and decarbonisation for manufacturing and process industries (Made in Europe and Processes4Planet Partnerships) (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Allow manufacturing and process industries to forecast market demands and reduce product waste with the support of digital technologies;

- Manufacturing and process industries will be enabled to achieve a considerable reduction of the ecological impact and carbon footprint through the use of innovative modelling and simulation software that allow real time process control and manufacture monitoring;
- Manufacturing and process industries will be facilitated by the development and uptake of digital tools/platforms (eg. EU Digital Product Passport) to increase traceability and characterisation of materials, including environmental footprint and quality;
- Initiatives for reducing barriers for the uptake of the digital tools from the market and empower new digital skills for the workforce;

Scope:

Manufacturing and process industries are effectively linked in ways that enhance circularity, facilitates decarbonisation and competitiveness. A broad range of digital technologies (AI, IoT, Data Spaces etc.) can be employed to achieve the systemic circularity and carbon neutrality of the European industries.

Advanced simulation tools integrated in the digital monitoring (digital twins) of the manufacturing process optimizing (improved decision) the whole value chain from chemistry, raw and advanced materials through manufacturing and distribution to the consumer. Predictive and data analytics can process a huge amount of data achieving a much deeper understanding of customer needs. In the process industries, the reduction of the carbon footprint and increase of circularity, can be achieved by merging the use of sensors and data processing capabilities. The application of digital twins in the process industries will allow accelerating the efficient design and efficiency of the plants as well as a higher safety of operations.

Data pooling and sharing (among other industries) would contribute to responsive value chains while also facilitate recycling by monitoring the life cycle of the products and components. To achieve that there is a need to build trust by ensuring data exchange and interoperability across industry sectors while also focusing on aspects like data quality, reliability, and accessibility.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should contribute to the concept of a materials acceleration platform: an ecosystem of tools and capabilities including materials modelling, characterization and data documentation, ontologies, which are orchestrated to accelerate the design, development and application of chemicals, materials and related processes/manufacturing.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnerships Made in Europe and Processes 4 Planet.

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-06: Manufacturing As A Service: Mass customised production on demand (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Availability of low-cost, industrial-grade technologies allowing to broaden the categories of products which can be custom-built on demand, at a price competitive with mass-manufactured products.
- Integration of automation technologies allowing to use different manufacturing facilities to manufacture a product, with minimal setup time and in a fully automated way, reducing transport costs and carbon emissions.
- Demonstrating the economic viability of mass-customised, on-demand product manufacturing, reducing the waste due to the mass manufacturing and transport of products that may not meet the requests of the market.

Scope: Manufacturing as a Service (MaaS) is a distributed system of production in which resources (machines, data, software) are offered as services, allowing many customers to access distributed providers to implement their manufacturing processes. This topic aims at developing and integrating the digital technologies needed to make MaaS technically and economically viable in the specific context of mass customised production, which has a high potential impact on the circularity and sustainability of manufacturing thanks to the potential reduction of waste and optimisation of logistics aspects.

Proposals should integrate and further develop digital technologies allowing to manufacture "on demand" a large choice of customised products, with extreme flexibility and short lead time, by using distributed manufacturing facilities as a service.

This will include the development of the appropriate factory automation techniques and the integration of real-time, data-driven technologies for the factory floor enabling the automation of the complete cycle from the customer order to the delivery of the product. Results should be demonstrated through at least one realistic use case.

Integration with digital design, development of design libraries and workflow templates, and prototyping techniques should also be taken into account, with the objective to optimise the entire lifecycle of the product in terms of circularity and sustainability.

The results of the action are expected to have a positive impact on both the competitiveness of industry and on the circularity and sustainability of the production processes. Proposals should explain how the proposed approach contributes to these objectives through measurable targets.

Proposals should address primarily the digital technologies enabling mass customised production, possibly complementing activities supported in other relevant topics like, e.g., "High-precision and sustainable production of complex products" and "Sustainable decentralised manufacturing close to the consumer". Proposals should also take into account

relevant activities supported under the Digital Europe programme, e.g., in the area of Manufacturing Data Spaces.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This topic implements the co-programmed European Partnership "Made in Europe".

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-07: Manufacturing As A Service: Smart value networks for resiliency and flexibility (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Availability of cockpit/control tower technologies to provide timely scoreboard views and alerts of failures and possible shocks in the supply chains.
- Availability of reliable models for specific value chains, enabling a better understanding of the impact of unforeseen events on manufacturing and industrial production.
- Availability of technologies to automatically adapt the production of goods and services to varying external conditions, improving the resilience of the industrial systems towards the intrinsic fragility of value chains, and the sustainability of the entire production process through continuous improvement.
- Industrial organisation models and smart factories that are intrinsically resilient and capable of self-adaptation in response to external threats, possibly following bio-inspired approaches.

Scope: Manufacturing as a Service (MaaS) is a distributed system of production in which resources (machines, data, software) are offered as services, allowing many customers to access distributed providers to implement their manufacturing processes. This topic aims at improving the viability of MaaS under real-world conditions characterised by high volatility of the supply, exploiting the advantages of MaaS in terms of resilience and circularity.

Proposals should develop realistic models of value chains, which allow humans to react timely and better understand the impact of external events on the industrial system, and to propose simulations and evaluations of scenarios that will appropriately respond to those events and optimise industrial production. Models should be robust enough to be usable even when the quality of input data is low or uneven.

The results of simulations should lead to instructions for distributed manufacturing facilities that can automatically implement the retained scenario and adapt production processes, stock levels and any other variables of the manufacturing and logistic flow, optimising production in terms of resilience, agility, and circularity. Collaborative engineering tools will support the management of distributed production processes under frequently changing conditions in a complex value network.

Resiliency to failures should be taken into account, resulting in the capability to guarantee useful outputs and reliable production even under non-optimal conditions. Multidisciplinary research activities should address the way to develop robust models on the basis of uncertain and incomplete data, and to translate those models into practically usable digital twins, which can produce actionable information and data.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination, and demonstrate their results through at least two realistic use cases.

Proposals should address primarily the aspects related to data and digital technologies of smart value network, possibly complementing activities supported in other relevant topics like e.g., "Systems integration and resilient supply chains in manufacturing".

The results will contribute to making Manufacturing As A Service technically and economically viable, and are expected to improve to both the competitiveness of industry and the circularity and sustainability of the production/logistic processes. Proposals should explain how the proposed approach contributes to these objectives through measurable targets.

This topic implements the co-programmed European Partnership "Made in Europe".

HORIZON-CL4-2023[2024]-TWIN-TRANSITION-01-08: Manufacturing As A Service: Support for innovation, technology transfer and standardisation (CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Animate a vibrant research and innovation community around the digital technologies enabling "Manufacturing as a Service".
- Support the transfer of information and technologies between Horizon Europe projects and other relevant initiatives, e.g., the Manufacturing Data Spaces and the network of European Digital Innovation Hubs.
- Identify best practices to improve circularity and sustainability of industrial production through Manufacturing as a Service.
- Identify existing standards which are relevant for the implementation and deployment of Manufacturing as a Service and perform a gap analysis to identify needed standardisation activities.

Scope: Manufacturing as a Service (MaaS) is a distributed system of production in which resources (machines, data, software) are offered as services, allowing many customers to access distributed providers to implement their manufacturing processes.

Proposals should support the research and innovation activities in this area, making available to the community of practitioners the information needed to interact with relevant initiatives like the Manufacturing Data Spaces and the European Digital Innovation Hubs.

The activities will include the organisation of events and workshops on technology transfer and collaboration, with a specific focus on best practices to support circularity and sustainability in industrial production through digital technologies in a “Manufacturing as a Service” context.

Proposals will provide an analysis of the relevant standardisation landscape, including in the area of Cybersecurity, identifying gaps between the existing standards and the needs for a full implementation of Manufacturing as a Service.

Only one proposal will be selected for funding.

This topic implements the co-programmed European Partnership “Made in Europe”.

1.2 A New Way to Build, accelerating disruptive change in construction

HORIZON-CL4-2023-TWIN-TRANSITION-01-11: Intelligent data acquisition and analysis of materials and products in existing built works (RIA)

Expected Outcomes:

- Faster and less labour-intensive identification, analysis and digitisation of materials and products from existing built works
- Increased supply of secondary materials and construction products for reuse
- Reduction in construction and demolition waste
- Improved facility to re-use construction products
- Improvements to labour productivity as a result of using the developed solutions

Scope:

Existing built works can potentially act as a significant 'material bank', providing a rich source of secondary materials and products for construction. This requires identification and analysis of the asset's components and materials, which typically involves slow, labour-intensive and costly processes. There is a need to research new digitally powered techniques and technologies that would rapidly and accurately identify, analyse and record existing construction materials, products and components, facilitating their use in a circular economy and reducing life cycle impacts including embodied carbon. Proposals would thus contribute to the aims of the New European Bauhaus.

Proposals should:

- Develop new techniques and technologies to rapidly identify materials, construction products and components of existing built works, or works that have undergone demolition
- Develop solutions that would rapidly analyse the properties and characteristics of materials, construction products and components, which may include for example material composition, dimensions, mass, technical/mechanical properties and performance, health and safety aspects such as performance in case of fire and the presence of hazardous substances, fixing methods, or other aspects
- Develop solutions to digitally record categorise and tag existing materials, construction products and elements for their eventual use on the market
- Research ways in which complex or concealed elements can be identified and analysed, for example materials within the make-up of walls and floors, hidden structures, or composite products
- Address ways to make circular use of the identified elements as secondary materials or reused products on the market in construction projects, and to track them and their characteristics over asset life cycles
- Address ways in which the characteristics of identified elements could be presented in a user-friendly manner to relevant actors such as construction professionals, including on-site workers

- Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.
- Additionally, a strategy for skills development should be presented, associating social partners where relevant.
- Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms, such as the New European Bauhaus.

HORIZON-CL4-2023-TWIN-TRANSITION-01-12: Enhanced assessment, intervention and repair of civil engineering infrastructure (RIA)

Expected Outcomes:

- Extension of the service life of civil engineering infrastructure
- Faster and more accurate detection and analysis of maintenance and repair needs in existing infrastructure
- Reduction in time between the occurrence of infrastructure maintenance and repair-related problems and the on-site intervention
- Reduced risks to health and safety of workers in carrying out tasks linked to infrastructure maintenance and repair
- Cost savings in terms of both operational costs and deferred or avoided capital investment costs

Scope:

Regular maintenance and repair of civil engineering infrastructure extends their service life, which in turn reduces the need for their demolition and replacement and the related negative economic and environmental impacts. However, it can be difficult and cumbersome to identify and address maintenance or repair needs, especially in locations that are difficult to access such as large or tall structures, deep shafts, or where elements are hidden from view. Intervention for maintenance and repair can also involve unnecessary risks to health and safety of workers.

Proposals should:

- Develop new technologies and solutions that facilitate timely identification of maintenance and repair issues in existing civil engineering infrastructure. Examples may include structural weaknesses, unacceptable deformation and fatigue, issues related to moisture including mould growth and corrosion, the effects of weathering and of weather-related events, faults in technical systems, leaks of water or chemicals, or other issues.
- Develop new solutions to quickly and accurately analyse and assess the need for intervention
- Develop solutions that would intelligently recommend and prioritise relevant and timely action to address the identified maintenance and repair issues

- Develop solutions that would carry out rapid, cost effective and safe intervention for maintenance and repair of infrastructure, for example using automated or remotely operated tools
- Address ways to reduce the risks involved with maintenance and repair, including the health and safety of workers
- Address ways to digitally record and continually update the maintenance and repair status of infrastructure assets and their component parts
- Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.
- Additionally, a strategy for skills development should be presented, associating social partners where relevant.
- Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms, such as the New European Bauhaus.

1.3 Energy Intensive Process Industries

Energy efficiency and climate neutral process industries

HORIZON-CL4-2023-TWIN-TRANSITION-01-31: Energy efficiency breakthroughs in the process industries (Processes4Planet partnership) (RIA)

Expected Outcome: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by designing industrial processes for a maximum energy efficiency, ensuring process flexibility and capturing the full potential of renewable energy (related to P4Planet operational objectives 1 and 5)

Projects are expected to contribute to the following outcomes:

- Energy intensive industries will achieve a step change in energy efficiency of industrial processes by reducing at least 20% of the energy use as compared to current state of the art; [1].
- Demonstrate contribution to EU climate neutrality goal;
- Demonstrate an increase in the use of renewable energy in combination with digitalisation of processes.

Scope: Decarbonisation of energy-intensive industries through use of low-carbon technologies will have to go hand in hand with the availability of affordable energy. This means not only producing more clean energy but using less. Today‘s energy efficiency increase in classical plants is of 1-2% annually. The use of digital technologies in process optimisation has the potential to reduce the energy used to a less extent. However, if digital technlogies are combined with highly efficient technologies this should lead to a significant energy reduction.

Proposals under this topic should:

- Focus on the innovation of the most energy intensive parts of specific processes;
- Demonstrate the decrease of energy intensity of output level (intermediate, final product);
- Demonstrate energy efficiency increase at fluctuating energy supply (e.g., variable energy mix);
- Handle variability in renewable energy production without loss of efficiency;
- Integrate novel technologies from the fields of distributed process control, data driven AI based optimisation, as well as connectivity, interoperability and edge and cloud concepts.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Proposals should consider participating in a Hub 4 Circularity (H4C).

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-32: Optimisation of heat energy flows in the process industry (Processes4Planet partnership) (IA)

Expected outcomes: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by enhancing process industries energy efficiency, ensuring process flexibility and capturing the full potential of renewable energy (related to P4Planet operational objective 1).

Projects are expected to contribute to the following outcomes:

- Energy intensive industries will be enabled to increase their energy efficiency through heat recovery and integration of heat pumps in the industrial processes;
- Demonstrate an increase the use of renewable energy for industrial processes;
- Contribute to achieving EU Climate neutrality goals.

Scope: More than 20% of the overall energy used in the process industry is heat. The topic focus would be on strong integration of technologies that allow heat recovery and use. One example could be heat pumps for high temperature (150-250C) applications for large thermal capacity (~1-20 megawatt), but not only – examples could also be heat exchangers (advanced or improved heat exchangers).

The proposals under this topic should:

- Consider the use of low environmental impact, high safety standard fluids and the use of advanced materials in the process development.
- Consider the competitiveness aspect/cost efficiency as well as the direct integration in existing processes.
- The exploitation plans should include preliminary plans for scalability, commercialisation and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used;
- The inclusion of a GHG avoidance methodology[1] is recommended to be in line with the criteria by other EU financing, e.g., Innovation Fund;

- Heat storage should be intermediary only.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. The proposals should exclude the heat power generation, being already addressed in Cluster 5.

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-33: Electrification of high temperature heating systems (Processes4Planet Partnership) (IA)

Expected outcome: Projects outcomes will enable achieving the objectives of the Processes4Planet partnership, and the transition of the process industry to climate neutrality, by developing new electrified processes, ensuring process flexibility and capturing the full potential of renewable energy (related to P4Planet operational objective 1).

Projects are expected to contribute to the following outcomes:

- Develop and demonstrate advanced electric heating technologies for process industry for high temperature systems;
- Prove the effectiveness of the GHG emission avoidance by using renewable electricity. Reduce by at least 30% compared to actual levels, process industry high-temperature heating systems GHG emissions;
- Increase utilisation of renewable energy sources in process industries to substitute fossil fuels;
- Efficient integration of renewable energy sources (locally available), considering also their intermittency and the possibility to offer demand-response flexibility;
- Prove the economic viability of the entire unit to compete with the fossil-based heating systems; projects should demonstrate a reduction of CAPEX, OPEX and CO2 abatement costs though the new developed technology(ies);
- Showcase the effectiveness of the GHG emission avoidance in the process industries as well as the scalability and the cost efficiency of the proposed concept;
- Increase the competitiveness of the European process industry improving the current process performance while reducing the process cost.

Scope: High temperature (over 400°C) industrial heating systems, powered by fossil fuel combustion, are responsible of 20% of process industries GHG emissions. Electrification of these heating systems with locally available renewable energy could represent a major reduction of the related GHG emissions. The topic focuses on the sustainable electrification of high temperature heating systems: furnaces, kilns and crackers. Proposals under this topic should take a holistic approach which may include aspects such as equipment e.g., advanced materials; integration of existing highly efficient technologies e.g., hybrid burners, microwave and plasma technologies, electric resistances; and/or the combination with digital technologies or hybrid modelling.

The topic will integrate technologies to make them practically and economically viable in the process industries; this should be demonstrated through at least two realistic use cases, which may include not only big (e.g., cement, steel, refining or chemical) but also smaller (e.g., ceramics, non-ferrous metals) systems, with demonstrable economic return. It may include the development of high temperature heat storage for flexible usage of electricity (load shifting) or renewable electricity production (production fluctuation).

The inclusion of a GHG avoidance methodology[1] is recommended, to be in line with the criteria by other EU financing, e.g., Innovation Fund.

Proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

[1] That should follow Innovation Fund methodology: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

HORIZON-CL4-2024-TWIN-TRANSITION-01-34: Green hydrogen as feedstock in innovative production routes (Processes4Planet Partnership) (RIA)

Expected outcomes: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by replacing fossil feedstock by green hydrogen, capturing the full potential of renewable energy sources, and ensuring process flexibility (related to P4Planet operational objectives 1 and 2).

Projects are expected to contribute to the following outcomes:

- Contribute to Mission Innovation 2.0 NZEID on ‘net-zero industries’ and its ambition for access to and use of near zero-carbon hydrogen will be a significant driver of the required shift;
- Efficient use and integration of GHG emission-free green hydrogen as a feedstock in the process industry, considering also fluctuation of availability;
- Showcase the technical and economic feasibility of innovative production routes using green hydrogen as feedstock;
- Increase the utilisation of renewable energy sources in process industries;
- Contribute to EU Climate neutrality goals by proving the effectiveness of the GHG emission avoidance in the targeted process.

Scope: Green hydrogen produced from renewable energy sources, does not lead to any carbon dioxide emissions when used and it offers a solution to decarbonise industrial processes, being an important enabler to meet the 2050 climate neutrality goal. In the energy intensive process industries hydrogen can be used both as feedstock (chemical or reducing agent) or as an energy carrier. The integration of hydrogen into new production routes as a feedstock will lead to major GHG emission reductions across several European industry sectors.

Nowadays, hydrogen is largely used in industrial sectors such as the chemical industries and refineries. In addition to the current processes, there are different production pathways under development using hydrogen as a chemical feedstock in low-carbon industrial processes. Hydrogen could be used as reducing agent in the production and recovery of metals, biogenic and circular carbon optimisation or in new process routes to produce platform chemicals (e.g., carbon-based waste streams or biomass). Using renewable hydrogen as feedstock l in these new processes will lead to major GHG emission reductions.

The proposals under this topic should aim at:

- Development of innovative production routes using green hydrogen as feedstock;
- Design, making the best use of simulation, modelling and IT tools, of the production process coupled/integrated with green hydrogen production onsite considering fluctuations in availability;
- Efficient integration of the new production process into the processing line, including downstream and upstream;
- Proven techno-economic viability of the process, which will be impacted by several parameters including the efficient use of the hydrogen as well as the value of the by-products, and the value chain from hydrogen production, storage, distribution and usage.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination

Additionally, a strategy for skills development should be presented, associating social partners when relevant.

International cooperation is encouraged, especially with participants to mission innovation "Net zero industries"

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-35: Turning CO2 from waste to feedstock (Processes4Planet partnership) (IA)

Expected outcomes: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by developing efficient CO/CO2 capture and purification technologies, and valorisation routes; and driving the partnership's innovation portfolio towards first of a kind demonstrator to de-risk investment (related P4Planet operational objectives 3, 4 and 9).

Projects are expected to contribute to the following outcomes:

- Master the production of (C1) carbon-based platform chemicals from CO/CO2 at reasonable costs to path the road to the production of a large range of chemicals;
- Showcase the system effectiveness for the GHG emission avoidance in the process industries as well as the scalability and the cost efficiency of the proposed concept
- Enable the economic viability of the entire unit to compete with the fossil-based production of chemicals;
- Prove the efficient integration and use of renewable energy sources, considering also their intermittency and the possibility to offer demand-response flexibility;
- Increase the competitiveness and resilience of the European process industry.

Scope: The proposals submitted under this topic are expected to demonstrate the efficient utilisation of CO/CO2 streams from point sources (e.g., large industrial installations such as steel, cement, refining and chemical plants) converting them into added value (C1) carbon-based platform chemicals. The technologies proposed should support cross-sectorial concepts and sector integration. The semi-industrial pilot plan demonstrators proposed should:

- Process significant amounts of CO/CO2 containing waste streams from energy intensive process industries;
- Include energy-efficient capture (e.g., use of waste heat in scrubbers, increased mass transport in intensified scrubbers, electrified systems or integrated capture and

conversion) and purification approaches of the CO/CO2 streams (e.g., advanced membranes and environmental friendly absorbents for cleaning formulations, compression, drying, concentration, etc.) fit for purpose while ensuring the maximum process efficiency;

- Demonstrate process efficient conversion of CO/CO2 to (C1) carbon-based platform chemicals (e.g., breakthrough and reliable catalyst) including if relevant process-integrated downstream products;

- Include energy efficiency and, where relevant flexibility, consideration of the overall CCU process and focus on the efficient use of renewable energy for capture and conversion.

The proposals will integrate technologies to make them practically and economically viable in the process industries reducing CAPEX and CO2 abatement costs. This should be demonstrated through at least one realistic use cases with demonstrable economic return developed in closed cooperation between CO2 industrial emitters, users and technology providers.

The inclusion of a GHG avoidance methodology[1] is recommended, to be in line with the criteria by other EU financing, e.g., Innovation Fund.

Proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

[1] That should follow Innovation Fund methodology: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

HORIZON-CL4-2023-TWIN-TRANSITION-01-36: Modelling of EU industry decarbonisation (Processes4Planet partnership) (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Enhance the knowledge and analytical capacity for the evaluation of how a competitive, circular and clean EU industry can best decarbonise and contribute to the EU's 2050 climate neutrality objective as defined in the EU Climate Law, a key milestone of the European Green Deal[1]. Considering the huge diversity of industrial

processes and materials, the project will focus on the decarbonisation of the Energy Intensive Industry, which is a big emitter of GHG emissions (15% of total GHG emissions in the EU today) and a priority in the decarbonisation effort while covering to the extent possible all industrial branches;

- Provide with a detailed picture of how intensive process industry produced materials and chemicals (including when embedded in consumption goods) are traded globally, or at least regionally, with relevant granularity up to 2050 and beyond, and innovative ways to integrate such capacity in a fully consistent picture;

- Contribute to future EU and national industry, climate and energy policy assessments. Decarbonisation of industry will be a strong priority for the EU and national policies by 2030 and towards 2050 considering that industry has been so far projected more difficult to decarbonise (compared to buildings sector or power generation). Any policy initiatives will require a strong, forward-looking analytical basis and such can be provided by modelling;

- In the longer term, this research would also benefit the process industries by enabling the framework conditions to develop market uptake at the scale of transformative solutions and products (P4Planet operation objective 10).

Scope: First, the research will look, at the EU (Member States level) as well as (with relevant granularity) at the global level, the following dimensions: Technologies and processes, notably in Energy Intensive Industries that are climate-neutral in relation with both energy needs and process GHG emissions, including electrification, hydrogen, new e-fuels or carbon capture possibilities; The research will cover "large scale" process industries materials whose supply represents currently a meaningful share of energy and/or GHG emissions of the economy. That will include "basic" materials (iron and steel, cement, chemical products, aluminium, glass, copper, etc.) The research will also look at whether other materials at the core of the digitalisation and the clean energy transition would be worth covering as well. Sectoral flows and stocks of these materials in the EU and global economy: historical and projections up to 2070 under various EU and global political, policy, trade and economic contexts (sectoral demand of materials, substitutability in consuming goods and equipment, scrapping and recycling, role of secondary production, trade flows, ..); The relation between materials used in building stock, consuming goods and equipment and the energy or GHG performance of building stock, goods and equipment.

Second, the research project will lead to the development of an integrated modelling capacity allowing to address the economics and behavioural aspects of demand, production and trade of materials, as well as techno-economic trajectories of the various relevant producing industrial sectors (representing the energy inputs, resulting GHG emissions and carbon balance of the industry). That would include (but not necessarily limited to) concepts from system dynamics modelling (for materials flows and stocks), techno-economic modelling (for the economics of production costs, elasticity of demand or trade effects), macro-economic modelling (socio-economics impacts), as well as agent-based modelling (choices of materials

or technologies). The resulting modelling and input data should be published under an open-source licencing.

Finally, the project should deploy this new modelling capacity to explore, through the development of several model-based scenarios, these different dimensions in a consistent way for both the detailed EU level and the global dimension. The scenarios should be contrasted but self-consistent political, policy and economic contexts, presenting different pathways for needs and supply of material and technological options to produce the materials in needed quantities, consistent with decarbonisation of the whole energy system.

Processes4Planet's Horizon Europe public private partnership ambition is to achieve a profound change in the way we produce and consume the materials that citizens need to sustain their quality of life. Processes4Planet is about transforming European process industries to make them circular and achieve overall climate neutrality at EU level by 2050, while enhancing their global competitiveness. Proposals should ensure the adequate involvement of the partnership advisory bodies i.e., "Impact Panel" and, as social innovation is concerned, the "feedback panel".

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Circularity and Zero Pollution in process industry

HORIZON-CL4-2023-TWIN-TRANSITION-01-37: Hubs for circularity for near zero emissions regions applying industrial symbiosis and cooperative approach to heavy industrialized clusters and surrounding ecosystems (Processes4Planet partnership) (IA)

Expected outcomes: Projects are expected to contribute to the following outcomes:

Process industries will achieve a step change in in circular utilization of resources (feedstocks and utilities) and GHG emission reductions of industrial processes within a given representative geographical area by reducing at least 20% of the use of resources as compared to current state of the art.

Holistic solutions, comprehensively illustrating the role that symbiosis and cross-sectorial cooperation can play in triggering an inclusive transition of process industries within their ecosystems: sharing resources, infrastructure investments, environmental benefits and paving the way for achieving Green Deal and "Fit for 55" package objectives.

Seed H4Cs to foster circularity within and beyond process industries (P4Planet operational objective 8). Drive the partnership's innovation portfolio up to "First of a kind" demonstrators to de-risk investment for subsequent roll-out. (P4Planet operational objective 9)

Citizens living in proximity of heavily industrialized clusters will benefit from a healthier industrial/urban symbiosis by less emissions through circular and renewable energy sources

Objectives/ targets:

- Overall energy efficiency gain for the region/area of at least 10% including utilization of heat recovery and digital power plants.
- Use of renewables as energy sources and green hydrogen as energy carrier to achieve up to 30% CO2 reduction at regional/area level.
- Top-up the previous achievements by applying or enlarging use of CCUS to the present local industries.
- Deploy one Industrial-Urban symbiosis near commercial scale demonstrator.

Important: the targets are meant to be achieved collectively by the region/area concerned, not only by consortium members.

This topic is aiming to support the goals of the smart cities and climate adaptation missions by contributing to a decrease of harmful industrial emissions while favouring renewable energy sources

Scope:

A large industrial symbiosis near commercial scale demonstrator should illustrate place-based innovation from local and regional perspectives, integrating infrastructures (e.g., industrial

waste, by-product and water management infrastructure, fluid flow networks), energy network and grids (for e.g., smart operations scheduling, district heat integration, digital power plant including distributed generation, seasonal storage, biomass, and heat pumps integration). Industries involved should boost their energy efficiency, heat recovery, and transform to use RES, hydrogen as an energy carrier, and implement locally CCU and CCUS. The deployment should comprehensively exemplify how symbiosis and cross-sectorial cooperation can trigger the transition by sharing resources and infrastructure investments. Regions or cross border area where large industrial clusters are already implemented should preferably be targeted if they can achieve high impact.

- Systemic solutions leading to H4C;
- Process (re-)design and adaptation to integrate new processes (energy and material flow coupling, infrastructure, and logistics) and exploit new synergies between sectors.
- Digital modelling tools as basis for resource management, including information on material streams in view of full integrated LCA.
- The transformation should build on significant increase of automation: cognitive plants and automation platforms, energy-aware factory analytics including data management.
- IT infrastructures and tools that provide a secure basis for the integrated management and the preservation of confidentiality of sensitive data.
- Use of established reporting methodologies for the assessment of industrial symbiosis activities and exchanges (including Symbiosis Readiness Levels, SRLs, best practices established by the ECoP)
- Development plan to extend the hub to additional players and multiply the local/regional synergies in the co-implementation of the identified innovations/ solutions.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-38: Hubs for circularity for industrialised urban peripheral areas (Processes4Planet partnership) (IA)

Expected outcomes: Projects are expected to contribute to the following outcomes:

Urban areas with high volumes of waste (household and end of life consumer waste) should closely interact with adjacent industries to jointly minimize CO2 footprint of industrial production and urban goods, improving urban waste management, developing smart recycling technologies and solutions, and thus contributing together to the valorisation of secondary materials and overall circularity. Hubs for circularity (H4C) concept is a pathway to exploit local synergies to deploy social innovative solutions engaging waste management actors in strategic nodes were novel value chains valorising a significant part of end-of-life wastes could connect.

Seed H4Cs to foster circularity within and beyond process industries (P4Planet operational objective 8) where they will play the role of a “system changer”. Drive the partnership’s innovation portfolio up to “First of a kind” demonstrators to de-risk investment for subsequent roll-out. (P4Planet operational objective 9)

Objectives:

- Large scale circularity demonstrator aiming at reducing urban waste by at least by 25%.
- Reduce by 80 % (in weight or volume) waste generated by the region/area in comparison to current situation, by re-using and transforming waste, by-products, and side-streams into new/secondary resources of raw materials.
- Reduce by 50% freshwater consumption of the area and/or re-use 90% of the solid waste generated by the water treatment
- Explore and detail at least 3 replication scenarios in similar areas in EU
- Set up a network amongst waste associations and hub partners including local/ regional authorities/ communities to facilitate and optimise flow and trading of secondary raw materials in the area.

This topic is aiming to support the goals of the smart cities mission by contributing to a healthier urban industrial symbiosis through waste reduction

Scope: Deploy the concept of Industrial-Urban Symbiosis (I-US) on a real scale demonstrator, making the flow of waste circular in process, manufacturing, construction industries and including household/urban wastes. Full attention should focus on upcycling back to secondary materials or products instead of down cycling of low re-use.

Projects are expected to address:

- A systemic solution for a H4C: closing circularity loops for mixed/combined materials streams based on upcycling and chemical recycling (including conversion and downstream, complex multi-material streams, valorization of waste streams (urban mine);
- Management and processing of waste streams through e.g., collection, disassembly, sorting, purification, concentration, recycling (especially chemical recycling), exchanging or preparation, for the valorisation of waste to be used as feedstock for other plants and companies across sectors and/or across value chains. Connections with manufacturing industries are expected;
- Innovative approach to end-of life materials;
- Digital modelling tools (including material passport) as basis for resource management, including information on material streams in view of fully integrated

LCA and Material Flow Analysis MFA (on diverse levels) and tagging/matrix for complex consumer products;

- Include local and regional authorities in an active partnership;
- Favour participative management with the local community and study social evolution impact of the hub, whilst also considering a gender and inclusiveness perspective.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-39: Hubs for circularity incubators (Processes4Planet partnership) (IA)

A definition of H4C should be available to proposers (format to be defined)

Expected outcomes: Projects are expected to contribute to the following outcomes:

Boosting the green industrial transition by a comprehensive proof of concepts /feasibility study of new H4Cs or significant extensions of existing ones. The target is principally technological i.e., filling in technology gaps for secondary or waste streams where currently no technology are applicable. To be included, H4C on existing brownfields with expiring fossil-based activities (e.g., coal or brown coal mines).

Seed H4Cs to foster circularity within and beyond process industries (P4Planet operational objective 8).

At least 3 of the following objectives should be reached collectively:

- Net Zero carbon emission in the hub.
- Zero freshwater consumption.
- Zero waste to landfill.
- 90% heat recovery.
- 100% RES
- 80% solid waste re-use as secondary raw material

In addition to the following achievements:

- Real scale demonstration of the different new cross-sectorial symbiotic value chains
- 3 adapted replication scenarios in 3 other EU regions/areas
- Business plan and fund leverage plan

Scope: support creation and benefit to already established hubs (extension, complexification, or replication). Digital tools, big Data, and AI will be essential for identifying cost-optimal pathways and new value chains as well as for the engineering of the circular economy (to make systems more effective and re-think negative externalization). Moreover, it will facilitate the necessary trustful knowledge sharing among processes and sectors for such complex deployment.

Project consortium should include all crucial actors for the future implementation of their solution (regional public administration, waste management authorities, energy distribution entity, some facilitation entity (might be the ECoP) and a cross sectorial industry participation including SMEs, civil society participation)

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-40: Sustainable and efficient industrial water consumption: through energy and solute recovery (Processes4Planet partnership) (RIA)

Expected outcomes: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by designing industrial processes for the maximum resource (water) efficiency and developing new process to ensure full valorisation of process industries wastewater, recycled water, energy, and solute recovery (P4Planet operational objectives 5 and 7).

Projects are expected to contribute to the following outcomes:

- Demonstrate sustainable water consumption based on new technologies for energy and solute recovery;
- Reduce process industry dependency and utilisation of fresh water by at least 20%;
- Prove the economic viability of the processes and technologies for water treatment and recycling;
- Demonstrate contribution to EU climate neutrality goals.

Scope: Wastewater discharge from industry has decreased over decades. This is caused by increased regulation (e.g., Industrial Emissions Directive, IED; the European Pollutant Release and Transfer Register, E-PRTR), improvements in treatment and the implementation of best available techniques reference documents (12). Industries that still have high direct releases to water include pulp and paper, steel, energy supply and chemicals (Ref. EEA Report 2021). Objective of P4P in 2030, 90% of wastewater reused. A breakthrough could be envisaged, by combining existing technologies and novel water treatment and re-use with process intensification, energy recovery and excess heat utilization approach (e.g., integrated processes with separation systems will reduce water and energy consumption). The proposals should:

- Combine existing technologies and novel water treatment and re-use with process intensification;
- Use in combination smart cheaper sensors and monitoring devices, integrated system risk management models and decision support tools and technologies for water re-use in process industries;
- Seek to integrate advanced Industry 4.0 tools for the optimisation of their process, such as Digital twins.

Proposals are encouraged to take into account outcomes from the H2020 Water cross cutting call of ASPIRE.

In addition, the topic could explore synergies with the Mission Oceans and Soil.

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-41: Breakthroughs to improve process industry resource efficiency (Processes4Planet partnership) (RIA)

Expected outcomes: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by designing processes for maximum resource efficiency (related to P4Planet operational objective 5).

Projects are expected to contribute to several of the following outcomes:

- Achieve a step change in the process industry's green transformation by enabling higher resource efficient processes with 30% lower consumption of resources and embodied CO_2 compared to the state of the art;
- Prove the techno-economic feasibility of novel technologies and processes, demonstrated and validated at suitable scale against current industrial processes to produce the same products;
- Overall positive environmental and if relevant health and safety impact proven by a sound LCA;
- Increase the competitiveness of the European process industry by significantly contributing to socio-economic growth;
- Demonstrate advanced concepts of cognitive and adaptive to variations Process Plants with ability for a plant wise distributed optimisation based on hybrid Process Control and data driven Artificial Intelligence methods.

Scope: Process industries will greatly benefit from radically new approaches that will lead to a much higher resource efficiency (including selectivity), producing less by-products and waste and enabling to cope with higher variability of feedstock. To reach ambitious targets regarding resource efficiencies disruptive process technologies must be developed in addition to process efficiency options for existing technologies. Projects under this topic could include breakthroughs to improve resource efficiency such as: Process intensification (e.g. 3D printed processes equipment, coupling of process steps, new processes that integrate multiple reaction steps, activation of molecules using renewable energy via alternative processes i.e. microwave, plasma); minimise waste (e.g. processes that adjust in real time to changes, develop tighter processing controls develop solutions to ensure higher yields from complex and fluctuating raw material feeds); . Where relevant advanced process technologies and their combination need to be developed supported by advanced materials innovation and the implementation of enabling digital technologies.

The projects should include energy efficiency, techno-economic and life-cycle assessment strategies consideration of the overall process.

Projects are encouraged to consider the use of their expected outcomes in a wider holistic approach that might benefit for the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-42: Circular economy concept: Upcycling large volumes of secondary resources (Processes4Planet partnership) (RIA)

Expected outcomes: Projects outcomes will enable achieving the operational objectives of Processes4Planet partnership by developing new processes for circularity of secondary materials from wastes/residues for all industrial processes (related to P4Planet operational objective 6).

Projects are expected to contribute to the following outcomes:

- Prove the technical and economic feasibility of the use of secondary resources in the process industry leading to products with identical properties and performances that those produced using primary resources and allowing production without quality restriction;
- Increase the use of secondary resources in the process industry driving to significant increase in resource efficiency and subsequent reduction on CO2 emissions; Reduction of waste sent to landfill and overall positive environmental impact;
- Increase the competitiveness of the European process industry; new business opportunities and revenue flows for recycling companies, benefiting particularly SMEs, which dominate this sector of the market;

- Foster data sharing, interoperability of data and FAIR principles between recycling companies and the process industry to improve the economy of scale in up-cycling of material streams;

- Increase the use of unused and new skills to unfold the potential of the technological solutions at the workplace for upcycling;

- At a longer term, to pave the way toward sustainable-by-design for circularity products.

Scope: Only 12% of the material resources used in the European process industry currently are recycled and recovered materials. To move towards a truly circular and sustainable process industry using its resources consciously, and without landfilling, breakthrough innovation aiming at upcycling large amounts of secondary resources are needed. The focus of this topic is the upcycling of secondary resources that must lead to the same quality and diversity of products as those obtained when using primary resources. The proposals under this topic may cover any of the process industries sectors and related end of life wastes (to the exception of plastics which were the object of the WP2021 22 and steel scrap part of Clean Steel partnership which are excluded). The innovation needed will depend on the addressed waste category. However, even if the upcycling technologies may be sector specific, the cross-sectorial elements are important and should deserve due attention.

Projects are expected to address:

- The upgrading of secondary resources, which may include the development of better separation and sorting technologies;

- Ensure consistent quality and safety of recyclates and its suitability for the upcycling process itself;

- If relevant detect and separate legacy additive in the waste stream;

- The upcycling of the secondary raw materials should be demonstrated through at least one two realistic use cases with demonstrable economic return developed in closed cooperation between recyclers, process industry, users and technology providers.

Successful upcycling relies on advanced monitoring and sensing in the process industries and value chains, and on an improved data completeness, accuracy and interoperability between the process and the recycling companies. Upcycling may create new business opportunities and models. These are aspects that should be duly considered. The proposals should include energy efficiency techno-economic and life-cycle assessment considerations of the overall process.

Proposals should consider key standardisation aspects and actively pursue the involvement of all the actors in the value chain from the process industry to formulators, recyclers, (public authorities and standardisation actors).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

Clean Steel

HORIZON-CL4-2023-TWIN-TRANSITION-01-43: Low carbon-dioxide emission technologies for melting iron-bearing feed materials (Clean Steel Partnership) (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Innovative or improved existing advanced melting processes for next-generation clean steel production, such as, but not limited to, solid material injectors, and feedstock preheating technologies.
- Integration of next-generation melting technologies into an existing and optimised steelwork, with the objective to enable gradual transformation towards a low CO_2 production sites. Proposed solutions should consider also the supply chain to strongly reduce the environmental footprint of the steel melting process;
- New quality parameters for newly available intermediate products (e.g. DRI) to be used in melting processes (e.g. DRI) should be developed including methods to assess them;
- Ensure castability of steel melted using low-CO2 emission technologies, as well as improvement of the yield, and efficiency of the process and quality of the product.

Scope: Proposals should address novel and adapted low-carbon-dioxide emission technologies for melting iron-bearing feedstock materials, including, among others, low-value iron-based sources, consider the assessment of material quality, and the use of CO_2-lean electricity. The focus is on the three technological routes of blast furnace–basic oxygen furnace (BF-BOF), electric arc furnace (EAF), and direct reduced iron/ hot briquetted iron form (DRI/HBI), while also including the refining and casting processes.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2023-TWIN-TRANSITION-01-44: Digital transformation and ensuring a better use of industrial data, which can optimise steel supply chains (Clean Steel Partnership) (IA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Extension of real-time process control to monitoring and controlling the impact on sustainability of the running process conditions to set up countermeasures to stay into the optimal process window; this includes, but is not limited to, set up of reliable energy and (intermediate) product quality forecasting, online comparison between forecast and realisation, control of metal slag;

- Enhancement of the in-line scrap classification through the continuous analysis of the bulk composition by applying a holistic approach considering the assembly of sensors, specific models, and advanced data processing;

- Novel sensors and models for real-time process control, such as, but not limited to, metal slag parameters (e.g. composition) and temperature measurement, slag analysis, off-gas analysis, energy forecasting to match demand and offered mix in the power grid considering energy generated from renewable sources, cooperation between steel and power players in the market. The expected outcome is an enhanced merging of planning activities and approaches to run plant processes;

- Application of Digital Twins, enhanced statistical analysis or machine learning (ML) algorithms to develop decision-supported planning and process monitoring tools operable in offline or online modes;

- Traceability of materials and process information throughout the value chain to promote improved product quality, efficiency and process integration control.

Scope: Proposals should focus on the reduction of the carbon footprint by merging the use of sensors and data processing capabilities. Large quantities of monitoring data capable to guide towards technical decision pathways and build relevant statistics should be coupled with outstanding analytical capabilities to help steel plant operators to increase the process yield and to improve the final steel product quality, while addressing the best approach to limit carbon emissions. The aim of the project is the application and integration of advanced digital technologies, such as integration of legacy into new architectures capable to supply data in a seamless way "when, where and what", artificial intelligence (AI), supercomputing and edge computing, cloud systems, and internet of things (IoT) to enable the competitiveness and high quality of green steel manufacturing technologies. The projects should ensure the involvement of operators and process experts in the design and development phases of digital technology integration, ensuring the uptake of human experiences and a user-friendly processing of results for easier industrial integration.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2023-TWIN-TRANSITION-01-45: Circular economy solutions for the valorisation of low-quality scrap streams, materials recirculation with high recycling rate, and residue valorisation for long term goal towards zero waste (Clean Steel Partnership) (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Implementation of highly efficient technologies for recovering iron and mineral fraction from in-plant steelmaking residues. The recovery technology should condition the composition and properties of the residue such as, but not limited to, slag, sludge, scale, filter dust, sinter waste produced by blast furnace/basic oxygen furnace

(BF/BOF) and electric arc furnace (EAF) routes, but also by next-generation steelmaking such as, but not limited to, direct reduced iron/ electric arc furnace (DRI/EAF) pathway. Two possible ways are envisioned, whereas the first one is based on cooling and mechanical steps, such as, but not limited to, wet or dry granulation followed by phase separation; the second one relies on a dedicated process to a direct recycling of residues in existing production processes or in standalone pyro-metallurgic melting and reduction units. Such knowledge and results should support the valorisation of the residues in the present value chain and/or in innovative applications;

- Describe and/or modify the composition and properties of residues such as, but not limited to slags and sludge produced by next-generation steel making, such as, but not limited to DRI/EAF pathway. Such knowledge and results should support the valorisation of the residues in the present value chain and/or in innovative applications;

- Enhanced utilisation of low quality scrap by new technologies in order to maintain the target quality of the finished product and reduce the CO_2 emissions. The aim is to remove scrap impurities (tramp elements) such as, but not limited to, copper before melting, for example through scrap yard management and charge preparation for quality upgrading, or after the melting in liquid phase, through, but not limited to, metallurgical methods;

- Technologies to broaden the types of ore grades utilized in different processes. The aim is to establish processes that allow for upgrade of low-grade iron ores to make them suitable for, but not limited to, cold bond agglomeration, pelletisation, or direct use in existing steelworks.

Scope: In the medium-term scenario, new technologies will enter in the iron and steelmaking production process: e.g. higher amount of scrap in basic oxygen furnaces (BOF), more electric arc furnace (EAF) based steelmaking, as well as more directly reduced production capacity are foreseen. Therefore, it is necessary to consider the influence of the feedstock quality, of the new production technologies and of the composition of the by-products generated on the present model of circular economy for both the economic and environmental aspects.

Recycling of steel scrap – being it home-scrap, industrial scrap or post-consumer scrap – and by consequence increasing the consumption of scrap, the recovery of iron from residue and the use of low-quality iron ore materials, are vital to diminish the need for additional primary resource extraction and hence to decrease the environmental impact of steel manufacturing. This is also contributing to a wise and sustainable management approach of iron resources. Proposals should consider higher utilisation of low-quality iron-bearing materials, in particular low-quality scrap, with higher amounts of unwanted elements (residual and alloying elements such as Cu, Sn, Sb, As and Bi, but also Cr, Mo, B) that prevent the production of many steel grades, higher utilisation internal residues, and the recycling of its metal contents. The aim is to obtain a sustainable vision of reduced virgin raw materials use.

Moreover, the existing recycling and reuse solutions for today's steel industry will be affected and new solutions need to be developed to maintain a sustainable development of the steel industry in the future. Projects should aim at the selection and integration of best available and applicable technologies supported by digital smart tools. These are key elements to improve and adapt circular economy solutions for long-term goal towards zero waste increasing the use of scrap, the materials recycling rate and the residue valorisation by targeting to achieve the same quality of the finished product and at the same time reducing CO_2 emissions due to lower energy need with respect to iron-ore.

Multidisciplinary research activities should address one of the following:

- New technologies for Reduce / Reuse / Recycle in the next generation iron ore and steelmaking process:
    - Increasing reuse and recycling of steelmaking slags;
    - Recycling and valorisation of dusts, and sludges;
    - Recovering iron and metal-fractions from in-plant residues;
    - Conditioning processes for the use of residues and low quality iron ore grades like application of cold bonded agglomerate: binders, raw materials composition and processing conditions;
    - Implementing Circular Economy and Industrial Symbiosis for long-term goal towards zero- waste.
- Sustainable and efficient scrap management and recycling aiming high-grade steel production with increased scrap rates including:
    - Improved mechanical scrap preparation coupled with scrap analyses;
    - Continuous analysis and monitoring of the scrap bulk composition using sensor systems with accompanied model-supported Big Data analytics for scrap classification;
    - Scrap yard management and charge preparation for quality upgrading;
    - Optimised and more flexible primary and secondary steelmaking processes considering enhanced scrap rates.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2024-TWIN-TRANSITION-01-46: CO_2-neutral steel production with hydrogen, secondary carbon carriers and electricity (Clean Steel Partnership) (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Introducing the use of secondary carbon sources, including biomass-origin material and circular carbon material – such as mixed waste based reductants – in the steelmaking process to target improved sustainability and to allow a technically and economically feasible transition to reduce the use of fossil carbon as fuel or reducing agent. While reducing the fossil carbon-related emissions, technologies to reduce steelworks energy consumption with improvements in the materials and energy flows should be considered;

- Reduction of carbon footprint by incrementally adapting to the use of low-CO_2 hydrogen to heat steel for deformation and heat treatment considering also coupling of hydrogen and electrical heating;

- Reduction of carbon footprint by transitioning to hydrogen-based reduction and melting processes;

- Positively impact the direct reduced iron (DRI) properties, such as, but not limited to, mechanical and metallurgical properties, reactivity, bulk behavior;

- Valorisation of non-conventional ores, e.g. in electrolysis processes;

- Substitute coal as carburiser and slag foaming agent by alternative materials in electric arc furnaces (EAF) and contribute to achieve low CO_2 steel production;

- Enhance residue handling of carbon-bearing residues and recovery of metal contents from low-value residues by pre-reduction or reduction smelting with hydrogen and/or electricity, such as, but not limited to hydrogen plasma smelting reduction;

- Develop technological pathways to increase the reutilisation of internal process metallurgical gases by deploying advanced gas treatment solutions.

Scope: Proposals should relate to metal reduction processes using hydrogen, renewable electricity or secondary carbon carriers, and/or to replace fossil fuels and reductants in steelmaking and in downstream processing in steel plants. Proposals under this topic are expected to provide concepts addressing the modifications of the existing installations of both liquid steel production, such as blast furnace–basic oxygen furnace (BF-BOF), electric arc furnace (EAF), and direct reduced iron (DRI) process, and heating and treatment of semi-finished products. Such modifications could concern the internal and external flows of energy and materials in order to re-use metallurgical gases (internal re-cycling) and to upgrade them with new sources, e.g. by replacement of fossil carbon both as reducing agent and heat sources with hydrogen and alternative carbon sources. This also includes the integrated preparation (reforming, separation, heating, compression) of external carbon-lean gases or internally recycled CO/CO_2 streams for efficient use as reducing agent in the BF, but not limited to or for use in heating process.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2024-TWIN-TRANSITION-01-47: Smart carbon usage and improved energy & resource efficiency via process integration (Clean Steel Partnership) (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Use advanced information and communication technology (ICT) to achieve process and energy integration and optimisation of the efficiency of steelmaking and downstream processing (heating and treatment furnaces) in steel plants;
- Improve the injection of metallurgical gases, as well as hydrogen-rich gases (e.g., a mixture of hydrogen and methane) and/or hydrogen, within the steel making processes;
- Adaptation of gas handling systems to new gases and their related properties;
- Utilisation and recycling of gases (e.g. carbon-containing process gases, oxygen, external gases, for example waste gases from a neighbouring chemical plant of syngas produced from an external pyrolysis plant) in integrated plants with mixed technology routes;
- Enhance production and energy management of integrated plants with mixed technology routes (e.g., blast furnace–basic oxygen furnace (BF-BOF) + direct reduction-electric arc furnace (DR-EAF)), to drastically reduce the consumption of coal and CO_2 emissions.

Scope: The steel industry should reduce their CO_2 emissions to the Fit for 55 targets, in particular by contributing to fulfil the new obligations foreseen in the revised Emission Trading System (ETS) Directive. Proposals under this topic should aim at the reduction of fossil fuel and reductant used in both blast furnace–basic oxygen furnace (BF-BOF) and electric arc furnace (EAF) steel production and, in turn, curtailing CO_2 emissions, using gas injection technology. To achieve the topic objectives, it could be relevant to consider technology improvement along with developing appropriate business models.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2024-TWIN-TRANSITION-01-48: Innovative steel applications for low CO_2 emissions (Clean Steel Partnership) (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Improvement of the in-use properties (e.g. of high strength and/or high ductility steels such as bainitic rails, quenched and tempered steels, car body sheets, pressure vessel steels and other steels that can contribute to a better carbon footprint) by controlling

the application properties (e.g. fatigue, embrittlement, internal and external corrosion and other properties relevant to service life in the application) by developing techniques (e.g. machine learning (ML), metallurgical/ thermodynamic simulations, finite element (FE) methods, realistic and applied testing methods) to improve the mechanical properties;

- New or modified alloying concepts and downstream processing methods for new fossil-free steels, as well as derivation of new test methods that are closer to reality into the industrial application;

- Innovative simulation methods and tools (e.g. Calculation of PHAse Diagrams (CALPHAD), crystal plasticity, artificial intelligence (AI), machine learning (ML), realistic and application-oriented testing methods, etc.) to accelerate clean steel development processes;

- Manufacture steels with improved life cycle contributions to CO_2 emissions reduction; this is the case for, but not limited to, the transport sector, which includes improved possibilities for reuse and remanufacture;

- Achieve enhanced grades of steel for use in efficient high temperature processes including thermal reactors for waste disposal;

- Obtain high-performance structural steels (e.g. high-strength, creep resistant, oxidation resistant etc.) not containing critical strategic elements (such as, V, Nb, Ti, etc.) characterized by increased tolerance to the content of contaminants in the scrap, such as Cu;

- Increasing the use of low-quality input materials (e.g. scrap, secondary raw materials, ores/dust) by new knowledge of the influences on the application properties of manufactured steel products tested under realistic operating conditions, taking into account the entire manufacturing process to identify the acceptance of buyers/users (incl. economic/ecological benefits, questionnaires, market research).

Scope: Proposals should address the production of clean steel for use in specific demanding environments. Of interest are steels and steel alloys capable to demonstrate high level of fatigue, as well as high resistance to pressure, heat, wear, cyclic loads, crash and corrosion conditions. The scope also covers the maximisation of low-quality materials and their influence on the product quality. Proposals should demonstrate CO_2 reduction potential by the application of their innovative steel solution.

This topic implements the co-programmed European Partnership on Clean Steel.

2. Destination: Increased Autonomy in Key Strategic Value Chains for Resilient Industry

Industrial leadership and increased autonomy in key strategic value chains with security of supply in raw materials, achieved through breakthrough technologies in areas of industrial alliances, dynamic industrial innovation ecosystems and advanced solutions for substitution, resource and energy efficiency, effective reuse and recycling and clean primary production of raw materials, including critical raw materials, and leadership in the circular economy.

2.1 Raw Materials for EU strategic autonomy and successful transition to a climate-neutral and circular economy

HORIZON-CL4-2023/2024-RESILIENCE-01-01: Exploration of critical raw materials in deep land deposits

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Develop innovative technologies for exploration of critical raw materials in deep land deposits in the EU and non-EU countries;

-Increase the resources and reserves of various primary critical raw materials within the EU and non-EU countries;

-Accelerate development of EU domestic critical raw materials exploration projects integrating innovative technologies that can form the basis for new EU SMEs and junior exploration companies.

-Strengthen EU autonomy and ethical sourcing of raw materials by developing socially and environmentally acceptable means of discovery of primary raw materials.

-Promote the utilisation of UNFC (United Nations Framework Classification for Resources) and UNRMS (United Nations Resource Management System) in the raw materials sector;

Scope:

Actions should map EU primary raw materials potential and raw materials production and refining capacities in a harmonised form, using UNFC (United Nations Framework Classification for Resources) and UNRMS (United Nations Resource Management System).

Develop new or improved highly efficient, sustainable exploration technologies, such as UAV assisted exploration in remote areas, geophysics, 3D modelling and new drilling techniques.

Actions should also contribute to improving the awareness of the general public across the EU about:

-The importance of raw materials for a successful transition to a climate-neutral and digitised economy and society; and

-The ensuing need for a secure, sustainable, and responsibly-sourced supply of raw materials, including from domestic sources to strengthen EU open strategic autonomy and reduce over-dependence on third countries.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-02: Innovative technologies for sustainable and decarbonised extraction

We are considering art. 22.5 for this topic.

Expected Outcome:

A secure supply of sustainable raw materials is crucial for the green and digital transition. Environmentally friendly, safe, intelligent and resource efficient extraction technologies and methods for both open pit and underground mining need to be developed and implemented.

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Develop innovative technologies for extraction of raw materials in the EU,

-Increase the domestic EU sourcing of raw materials,

-Promote the utilisation of UNFC (United Nations Framework Classification for Resources) and UNRMS (United Nations Resource Management System) in the raw materials sector,

-Accelerate development of EU domestic raw materials exploration projects integrating innovative

Scope:

Actions should develop new sustainable concepts and technological solutions, including alternative approaches, for mining of complex or difficult to access mineral deposits, including mining wastes and abandoned mining sites, particularly addressing the challenges of accessibility, industrial viability, safety and environmental impacts.

Actions should be driven by industry and raw materials users. The actions should justify the relevance of targeted minerals and metals. Priority are the EU critical raw materials[1]. Sea mining is excluded from this topic.

Actions should finish at the TRL levels 4-5.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

[1] https://ec.europa.eu/growth/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-03: Technologies for processing and refining of critical raw materials

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Increase recovery rates of valuable raw materials, particularly critical raw materials;

-Significantly increase economic performance in terms of higher material-, water-, energy- and cost-efficiency and flexibility in minerals processing and metallurgical processes;

-Significantly improve the health, safety and environmental performance of the operations throughout the whole life cycle which is considered, including a reduction in waste, wastewater and emissions generation and a better recovery of resources from generated waste;

Scope:

Actions should demonstrate new or improved systems integrating relevant processing and refining technologies for better recovery of raw materials from low grade and/or complex ores from extractive wastes, less waste, higher energy efficiency. The action could also reduce the content of toxic elements or compounds in the resulting material products. The actions should target minerals and metals, particularly Critical Raw Materials[2].

The solution proposed should be flexible enough to adapt to different or variable ore/secondary raw material grades and should be supported by efficient and robust process control. Where relevant, any solution proposed for the reduction of the content of toxic elements or compounds in the resulting materials should also include the appropriate management of the hazardous substances removed.

Actins should develop intelligent and innovative production systems which better utilise natural resources by minimising losses during waste-rock separation in an optimised and energy-efficient process.

[2] Ref list of EU CRMs 2020

Recycling of end-of-life products is excluded from this topic.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-04: Recycling technologies for critical raw materials from EoL products

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors which will alleviate critical raw materials dependency. Projects are expected to contribute to the following outcomes:

-Develop raw materials recycling from end-of-life products technologies and urban mines, including efficient sorting technologies for separation and recycling.

Scope:

Actions should develop material efficient high-quality recycling and preparation for re-use of the following end-of-life product categories/key waste streams: waste electrical and electronic equipment (WEEE), waste batteries, end-of-life vehicles[3], waste windmills[4] and solar PV. Only critical raw materials will be considered eligible for the actions. Rare earths permanent magnets are excluded from this topic since they are subject to a dedicated call XXX.

Their processing, reuse, recycling and recovery schemes are complex and imply different steps, ranging from collection, logistics, sorting and separation to cleaning, refining and purification of materials.

1.1 [3] With the exception of permanent magnets in motors which are included in action 11: ERMA action plan on rare earths magnets: Recyclability and resource efficiency of Rare Earth based magnets

[4] With the exception of permanent magnets in motors which are included in action 11: ERMA action plan on rare earths magnets: Recyclability and resource efficiency of Rare Earth based magnets

Actions should focus on the whole chain of recycling processes and procedures - from collection, logistics, sorting, cleaning, refining and purification of secondary raw materials and quality of produced outputs.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-05: Earth Observation platform for raw materials

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Develop innovative technologies, products and services based on satellite, airborne and in situ Earth Observation data, supporting the whole raw materials value chain, from mineral exploration to post-closure activities;

-Improve mineral exploration at regional scale and target definition at local scale, exploiting multi- and hyperspectral satellite and airborne sensors;

-Monitor the volume and rate of extraction of minerals in opencast mining based on airborne and satellite very high-resolution imagery;

-Map and monitor secondary raw materials in the EU based on high-resolution CORINE and hotspot-based VHR land cover products;

-Monitor ground stability in active and/or abandoned mining areas in the EU, exploiting the Ground Monitoring Service of Europe (GMES) and similar initiatives;

-Develop best practices and standards for innovate EO technologies, products and services in the raw materials life cycle;

Scope:

Actions should develop an Earth Observation platform for raw materials similar to ESA exploitation platforms that can facilitate access to developed EO technologies, products and services to the mining industry and public stakeholders.

The Earth Observation platform for Raw Materials should support the implementation of the EU's international strategic partnerships with resource rich countries (e.g. Canada, Ukraine, Serbia, Africa or Latin America).

Actions should increase the uptake of the Earth Observation technologies to deliver a responsible and sustainable mining industry, while creating create a sustainable business model for applying Earth Observation technology in the Raw Materials sector.

Actions should deliver on-line processing tools, services and products to generate value-added raw materials information products, pre-processed optical and radar data from the Sentinel satellites of the EU Copernicus programme, as well as access to data and services from other high-resolution satellites, airborne and in situ data.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-06: Expert network on Critical raw materials

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-strengthening the expert capacity in the EU in a wide range of raw materials along the whole value chain;

-better informed and more effective decision-making by the EU and Member States policy makers and the producers and users of raw materials regarding the supply and demand of raw materials and the associated environmental and social aspects;

-improving EU official statistics and to building the EU knowledge base of primary and secondary raw materials.

-improving awareness of society across the EU about importance of the critical raw materials and other relevant materials for strategic value chains in support of the implementation of the green and digital transitions;

-in the longer term improved diversification of CRMs supply to the EU.

Scope:

Actions should strengthen an EU expert network and community covering all raw materials screened in the CRM assessment of 2020 , and once available also the raw materials of 2023 assessment. The consortium should organise the expert community across the EU covering expertise on primary and secondary resources; production, including exploration, mining, processing, recycling and refining; substitution of CRM; raw materials markets; future demand and supply; supply risk management and stress tests; materials flows; raw materials standardisation; socio-economic analysis, and strategic value chains and end-use sectors, including batteries, e-mobility, renewable energy, electronics, defence and aerospace.

The actions should improve data and knowledge on all screened raw materials; flexibly support the Commission in policy making related to CRM in general or linked to specific applications or sectors; as well in the relevant events organised by the Commission. The actions should also support the Commission in the analysis of the future supply and demand of raw materials, technology gaps and innovation potential along the raw materials value chains.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-07: ERMA action plan on rare earths magnets: Rare Earth and magnets innovation hubs

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Significantly improve supply security and reduced environmental footprint of rare earth value chains in the EU
-Broad access to materials development facilities and services across Europe through a single entry point – innovation hub;
-Accelerate development of products and processes for a faster market entry;
-Reduce costs for both industry and users and increased return on investment in research;
-Improve access to end users and easier marketability of products in Europe;

Scope:

The action should create an innovation hub that enables the development, demonstration and testing of new processes for production of rare earths and related products, particularly neodymium permanent magnets in the industrial environments. This hub should connect critical mass of the existing laboratories, industrial pilots and other research facilities and services across different regions in the EU and if duly justified also in third countries.

The hub should demonstrate its functionality on a range of concrete developments up to the TRL levels 6-7 to be executed within the duration of the action. Demonstrations could cover novel, cost-effective and environmentally sound rare earths extraction, processing and separation routes; consider unconventional rare earth sources, like low grade ores, non-ferrous metals beneficiation tailings and iron ore tailings, metallurgical waste apatite; and/or recycling of end-of-life products containing rare earth magnets. The hub could additionally address development of breakthrough processing and separation approaches, finishing at TRL levels 4-5.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-08: ERMA action plan on rare earths magnets: Recyclability and resource efficiency of Rare Earth based magnets

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Development of more cost effective and resource efficient rare earth permanent magnets.

Scope:

Actions should improve design of rare earth permanent magnets that facilitate the reuse and recycling and/or reduce the use of the critical raw materials. Priority is neodymium magnets, but other highly performant magnets can also be targeted if properly justified. The actions should finish at the TRL levels 6-7 and developed magnets and their recyclability should be tested in the final application relevant motors or generators.

Actions could additionally address disruptive technologies for highly performant magnets.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-09: Addressing due diligence requirements in raw materials supply chains. Need for more responsible sourcing and responsible business conduct initiatives with regards to raw materials

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Improve responsible sourcing of raw materials;
-Strengthen knowledge in the supply chain due diligence for raw materials which will enable implementation of relevant regulatory initiatives;
-Identify and address gaps in due diligence;
-Contribute to the implementation of the EU Action Plan on Critical Raw Materials: Action 10

-Promote responsible mining practices for ciritcal raw matreials through the EU regulatory framework and relevant international cooperation[5];

Scope:

Responsible sourcing and due diligence are growing in importance throughout the raw materials value chain, highlighting the need to address possible risks of adverse impact to human rights and the environment in corporate behaviour. Consumers and investors increasingly expect supply chain transparency where due diligence obligations are an important part. Recent regulatory initiatives are underway for responsible sourcing and supply chain due diligence.

Knowledge in the area supply chain due diligence needs to be strengthened to limit complexity and enable a level playing field for responsible sourcing of raw materials.

The proposal should build on the state of the art in sustainable raw materials traceability.

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023/2024-RESILIENCE-01-10: Technologies for extraction and processing of critical raw materials

We are considering art. 22.5 for this topic.

Expected Outcome:

Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

-Strenghten EU cooperation with resource rich countries;

-Diversify EU sourcing of critical raw materials from third countries;

[5] COM (2020) 474

Dissemination and exploitation of projects outputs is tailored for organisations and industry dealing with raw materials in the EU and project partner countries in resource rich countries;

In order to achieve the expected outcomes, international cooperation with partners established inresource rich countries with which the EU has strategic partnerships on raw materials is strongly encouraged.

Scope:

Actions should focus on developing and demonstrating extraction and processing technologies to facilitate exploitation of the primary raw critical raw materials[reference] (minerals and metals only) for the EU. The actions should be driven by industry and raw materials users and finish at TRL levels 6-7. The actions should improve industrial viability, safety and environmental impacts of the operations.

International collaboration is encouraged, particularly with countries with which the EU has strategic partnerships on raw materials. [Add reference]

Actions should envisage clustering activities with other relevant selected projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues and share of results as well as participating in joint meetings and communication events. To this end proposals should foresee a dedicated work package and/or task, and earmark the appropriate resources accordingly.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

2.2 Safe and Sustainable by Design (SSbD) Chemicals and Materials

HORIZON-CL4-2023-RESILIENCE-01-21: Innovative methods for safety and sustainability[6] assessments of chemicals and materials (RIA)

Expected Outcome:

Proposals are expected to contribute to the following outcomes:

- Existing validation networks or bodies (e.g., ECVAM and OECD) or other entities wanting to engage in validation of new methods shall have access to results in a standard format that will allow them to launch a validation process as required to promote wider uptake of the new methods ;
- Standardisation bodies (OECD, ISO, CEN) should be fed with results of the projects as relevant for ongoing files;
- Industry and public authorities have access to innovative tools for more comprehensive safety and sustainability assessment covering a wider range of chemicals and (nano)materials including composites/mixtures;
- The European Commission have access to innovative tools and data to support the Safe and Sustainable by Design criteria;
- EU strategies/policies such as the Sustainable Product Initiative[7] or Ecodesign[8] have access to new methods and the associated data needed to assess their usability in the given context.
- Support the goals of the cancer, oceans and water, and soil missions by contributing to a decrease of harmful substances on the market to protect the citizens and the environment.

Scope:

In the EU, the legislation regulating chemical substances often includes their safety screening and testing according to the EU test methods regulation[9], which predominantly contains test methods developed under the OECD[10]. For safety assessment, e.g., human and eco toxicity,

[6] Reference to SSbD SWD for definition of safety and sustainability aspects.
[7] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en
[8] https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign_en
[9] https://eur-lex.europa.eu/legal-content/GA/TXT/?uri=CELEX%3A32008R0440
[10] OECD work on endocrine disrupters: http://www.oecd.org/env/ehs/testing/oecdworkrelatedtoendocrinedisrupters.htm

there is a lack of *in vitro* and *in silico* tools for a variety of substances and materials. These tools are needed to advance alternative testing methods without animal models, but also to support upfront modelling and design of new SSbD chemicals and materials. Research should improve and harmonise screening and testing protocols/strategies and hazard/risk assessments by developing robust, reliable and faster tools, test methods or models, high-throughput and *in silico* methods

Sustainability aspects cover production, use and end of life. Sustainability assessment across the life-cycle is a new emerging demand and methods addressing adequately the features of chemicals and materials are lacking. The integration of life cycle assessment with risk assessment is likewise a challenge. New and improved approaches are needed to increase the quality, the efficiency and the effectiveness of existing methods to drive innovation and to bridge data gaps required for sustainability and life-cycle assessments.

Proposals should consider all the following activities:

- Address a set of at least 3 chemicals/group of chemicals/(nano)materials for which they will develop new methods, tools and models for safety and sustainability assessment along their life-cycle. Selected materials can be composed of/contain the selected chemicals. The justification for their selection should include socio-economic aspects and a gap analysis[11] with regards to existing methods and models and their relevance to improve current SSbD assessment;

- Methods, tools and models developed can be either for existing chemicals and materials or to be used during the design phase of new chemicals and materials;

- For each method, model or tool developed and 'in project' validation should be done of the methods developed and an initial standardisation or validation dossier shall be prepared and submitted to an appropriate body/initiative.

- Data produced during the development process and in particular for inclusion in the validation/standardisation dossier must be FAIR[12] and shared though available platforms (e.g. IPCHEM, Chemicals data platform). Data for the validation/standardisation dossier shall be produced according to existing guidelines and stored in standardised data formats (ref to web page to be developed by JRC).

- Models developed should be made findable through the modelling platform to be developed by PARC[13].

[11] Reference to SSbD SWD to be added
[12] https://www.go-fair.org/fair-principles/
[13] https://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/ec_rtd_he-partnerships-chemical-risk-assessment.pdf, https://www.efsa.europa.eu/en/funding-calls/european-partnership-assessment-risks-chemicals-parc o(to be updated)

- Enhance international collaboration on uptake of new methods involving relevant players from academia, public and private sector as well as local authorities and communities..

Proposals submitted under this topic should demonstrate synergies with PARC and other relevant H2020 and Horizon Europe projects (especially within the call HORIZON-CL4-2021-RESILIENCE-01) and build on the extensive experience from European, national or regional clusters/platforms and initiatives such as Malta Initiative[14].

Research should build on existing standards (test guidelines and guidance documents) or contribute to standardisation. Interoperability for data sharing should be addressed. International cooperation is encouraged.

[14] https://www.bmu.de/en/topics/health-chemicals/nanotechnology/the-malta-initiative

HORIZON-CL4-2023-RESILIENCE-01-22: Integrated approach for impact assessment of safe and sustainable[15] chemicals and materials (RIA)

Expected Outcome:

Proposals are expected to contribute to the following outcomes:

- Developers and providers of Safe and Sustainability by Design chemicals and materials will be enabled to include a suitable integration approach for health, environmental and economic assessments in their models;
- Public authorities will be enabled to include integrated economic (incl. cost and benefits), human health and environmental assessment of safety and sustainability impacts of chemicals and materials along the life-cycle in regulatory decision making;
- The stakeholder community will be able to follow common existing or newly developed guidelines and methodologies for integrative health and environment impact assessments and economic analysis;
- Support the EU climate ambitions by contributing to a decrease of greenhouse gas emissions through a more sustainable production and use of chemicals and materials;
- Support the goals of the cancer, oceans and water, and soil missions by contributing to a better assessment of the different impacts of harmful substances on citizens and the environment;
- Industry and policy makers will be enabled to assess trade-offs between economic, health and environmental impacts.

Scope: Proposals should aim to develop integrated approaches for the assessment of the sustainability of chemicals and materials, covering aspects of health impact and environmental impact assessment as well as and economic analysis, all along the life-cycle of a chemical or material. The projects should acknowledge and account for the fact that sustainability of a chemical or material is the result of a mix of intrinsic properties (dependent only on the chemical or material itself) and extrinsic properties (dependent on how the chemical or material is produced or used, and in which quantity). The proposals should also aim to and foster their acceptance of the developed approaches as good practice. The work should build on the published criteria for Safe and Sustainable by Design[16]. The developed models should support and facilitate decision making when having to weight different sustainability criteria against each other in terms of costs and impacts.

With regards to health impact assessment projects should seek for coordination with projects resulting from the call *'HORIZON-HLTH-2022-ENVHLTH-04-01: Methods for assessing health-related costs of environmental stressors'*

[15] Reference to SSbD SWD for definition of safety and sustainability aspects.
[16] Add reference to SSbD SWD

Proposals should consider all the following activities:

- Address selected chemicals/group of chemicals/(nano)materials for which they will develop an integrated approach for sustainability assessment (covering health, environmental and socio-economic elements) and justify this selection in view of its societal relevance;

- Identification of data gaps and data availability along the value chain as regards all environmental, health and socio-economic factors for the targeted substance/group of substances and related tangible and intangible costs and recommendations on priorities for new data collections;

- Development of innovative tools, methods and models, and associated guidelines for integrated health and environment impact assessments and related cost-benefit analysis;

- Involvement of various stakeholders along the value chain to consult on tools, models, methods and assessments and developed a shared agreement on these;

- Social and economic aspects shall be integral part of the safety and life cycle assessment;

- Delivery of FAIR[17] data to an open knowledge data base including results, methodologies and data appropriate for re-use, data verification and curation, quality management, auditing and accreditation systems. Models under development as well as final models should be notified to PARC[18] and projects funded under HORIZON-CL4-2021-RESILIENCE-01-08[19] for referencing on their websites.

Research should build on existing standards (test guidelines and guidance documents) and contribute to standardisation. Interoperability for data sharing should be addressed.

Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH), in particular in economic assessment, to achieve efficient integration of techno-economic, safety and life cycle assessment.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. Proposals submitted under this topic are strongly encouraged to participate in networking and joint activities, as appropriate. This should also involve networking and joint activities between all successful projects funded under this call and other relevant clusters and

[17] https://www.go-fair.org/fair-principles

[18] https://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/ec_rtd_he-partnerships-chemical-risk-assessment.pdf, https://www.efsa.europa.eu/en/funding-calls/european-partnership-assessment-risks-chemicals-parc (to be updated)

[19] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2021-resilience-01-08

pillars of Horizon Europe, or other EU programmes, as appropriate. Therefore, proposals are expected to include a budget for the attendance to regular joint meetings and may consider to cover the costs of any other potential joint activities without the prerequisite to detail concrete joint activities at this stage. The details of these joint activities will be defined during the grant agreement preparation phase.

HORIZON-CL4-2023-RESILIENCE-01-23: Computational models for the development of safe and sustainable by design[20] chemicals and materials (RIA)

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- The European chemicals and materials community will be provided with computational models where chemicals & materials functionalities are integrated with Safe and Sustainable by Design criteria, supported by Artificial Intelligence technology;
- The innovation capacity of European SMEs and industry will be boosted with cost effective tools to find safe and sustainable alternatives to substances of concern;
- Industry will be enabled to develop SSbD chemicals and materials through knowledge on comprehensive design options linking functionality, safety, sustainability, processes, ontologies and databases;
- Improve the agility of European industry responses to external and internal influences, e.g. new market demands or regulatory requirements;
- Industry will lower the environmental footprint of materials & chemicals through improved production methods and optimised applications and increase human health and safety;
- The EU climate ambitions will be supported by contributing to a decrease of greenhouse gas emissions through a more sustainable production and use of chemicals and materials;
- The goals of the cancer, oceans and water, and soil missions will be supported by contributing to a decrease of harmful substances on the market to protect citizens and the the environment

Scope: For an effective and climate-neutral substitution of substances of concern[21] it is crucial that the developed alternatives provide the functionality that is required of those that are replaced (e.g. water or dirt repellent properties, insulation, etc.), and have an improved safety and sustainability performance. The integration by computational modelling of the chemicals and materials functionality with SSbD criteria will have a key role in the green and digital transition of European industry. These tools will allow the exploration of which technical solutions are the most appropriate in a cost- and policy-effective manner and accelerate the innovation process for SSbD chemicals and materials. Proposals should therefore:

- Develop innovative modelling software available and interlinked through open platforms accessible to SMEs and industry. Build on high-throughput materials

[20] Reference to SSbD SWD for definition of safety and sustainability aspects.

[21] Preliminary definition as provided in the Chemicals Strategy for Sustainability: Substances "having a chronic effect for human health or the environment (Candidate list in REACH and Annex VI to the CLP Regulation) but also those which hamper recycling for safe and high quality secondary raw materials."

characterisation facilities and relevant models, reinforcing strategic European position in the new data era;

- Enable the integration of materials modelling, safety and sustainability assessment tools and databases into a single work-flow. Apply AI techniques for data search and missing data, including statistical analysis (sensitivity and uncertainty), in all the areas covered: modelling of the functionality, safety and sustainability assessment (including Life Cycle Assessment);

- Address information exchange on chemicals and materials along value chains and throughout their life-cycle and provide solutions for data accessibility in the different steps of the value chain for modelling/assessment purposes;

- Apply FAIR data principles. The interoperability for data sharing should be addressed, including synergies with other European project addressing ontologies for data documentation, for example DT-NMBP-39-2020;

- Research should build on existing standards, where possible, and contribute to standardisation;

- Exploring collaboration with existing Open Innovation Test Beds (OITBs), where relevant.

- The tools should be validated against measurements and existing data. Application of the tools by external users should be tested within the project (industry and SMEs outside the project consortium).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

A strategy for skills development should be presented, associating social partners when relevant.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. For example the European partnership for the assessment of risks from chemicals (PARC) and HORIZON-CL4-2021-RESILIENCE-01-08.

HORIZON-CL4-2024-RESILIENCE-01-24: Development of safe and sustainable by design[22] alternatives (IA)

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- European industry will have access to safer and more sustainable alternatives with reduced substitution barriers (e.g. performance, cost and supply demand);
- Industry will be able to demonstrate relevant scale production of innovative chemicals or materials to substitute those of concern and with compliance with SSbD criteria;
- SMEs and industry will be enabled to integrate SSbD in their decision making, reduce time and resource intensity for safety and sustainability assessment across value chain stakeholders;
- The EU climate ambitions will be supported by contributing to a decrease of greenhouse gas emissions through a more sustainable production and use of chemicals and materials;
- The cancer, oceans and water, and soil missions will be supported by contributing to a decrease of harmful substances on the market to protect citizens and the environment
- *Social Sciences and humanities expected outcome to be added.*

Scope:

Proposals should develop (and where necessary design new) chemical substances or materials to replace existing substances of concern with surfactant, flame retardant or plasticising functionalities. Proposal should select one or more of them and address at least one industrial application. The new substances or materials shall be compliant with the SSbD criteria published by the European Commission. The selected industrial application areas should be where substitution with safer and more sustainable solutions is not yet in place, or in progress. Proposals should address all of the following:

- The selection should be justified with a technology and economic analysis.
- Identify the substitution barriers for the selected applications and propose driving mechanism for a full substitution in the targeted value chains.
- Exploring collaboration with existing Open Innovation Test Beds (OITBs), where relevant.
- Interoperability for data sharing should be addressed across the entire value chain. Proposals should involve the relevant actors along the value chain.

[22] Reference to SSbD SWD for definition of safety and sustainability aspects.

- Proof of concept of SSbD criteria. The developed substances or materials will have to comply with the SSbD criteria defined. Findings from the selected projects will be considered for the further refinement of the defined criteria, if applicable.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH), in particular in the socio-economic analysis of the relevant substance or application.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

2.3 Strategic Innovation Markets Driven by Advanced Materials

HORIZON-CL4-2023-RESILIENCE-01-32: Bioinspired and biomimetic materials for smart fabrics and sustainable textiles (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- The innovation market of sustainable textiles requires the use of a new generation of renewable and recyclable materials designed with properties that are inspired by nature.
- Bioinspired and biomimetic advanced materials that do not require chemical additives or coatings will have a positive impact on the environment and the circularity of textile materials, in view of SSbD.
- Smart functions or functionalities of textiles will address the advanced consumer market.
- Designed circularity for renewables and recyclable materials supporting the sustainable use of textiles.

Scope: Proposals should address one of the following activities:

- Bio-inspired and biomimetic polymers for use as smart textile materials will provide improved functionalities e.g. for outdoor use.
- The molecular functionalities of natural polymers, and their macromolecular structures and properties, provide inspiration for designing different classes of high-performance polymeric materials that aim to reproduce specific functions of natural polymers, such as adaptability, self-healing, adhesiveness, surface super-hydrophobicity, chiral recognition, and bioactivity.
- Biodegradability and recyclability of polymers will be a factor, so the consideration of natural polymers, such as polysaccharides, proteins, Lignin based polymers and composites could be a pathway.
- Projects must prove scalability of biomimetic materials for the manufacturing process of smart fabrics and sustainable textiles.
- To enable a fast development of new advanced materials, digital tools such as modelling, simulation and characterisation techniques are under the scope, assisted by advanced methods e.g. physics-based methods, machine learning or artificial intelligence.
- Dove-tailing with digital technology is encouraged

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

HORIZON-CL4-2023-RESILIENCE-01-33: Smart sensors for the home and personal products market (RIA)

Expected Outcome:

Sensors are a key technology for our society. From manufacturing, improving living conditions, and reducing consumption of energy and precious natural resources, even detecting threats, all rely on the availability of high-quality localized information.

Smart systems and ubiquitous connectivity create opportunities for new applications in smart living, environmental protection, and supply chains. These applications will be made possible through improved sensing technologies, which capture the relevant information. Core properties to enable a wide adoption are miniature size, low power consumption, resilience to varying ambient conditions, low cost, and compatibility with mass production.

The desired information is often chemical or biochemical. Miniaturization of established analytical methods and development of new materials compatible with established production processes require an integrated multidisciplinary approach.

Projects are expected to contribute to the following outcomes:

- The Innovation market for Home and Personal care is very broad and fast developing with a range to monitor human and environmental factors, which require to develop materials for a new generation of fast and smart sensors devices.
- Distributed smart sensor technology can also support environmental monitoring, supply chain management.
- Sensor devices must be small, and durable to deploy at various locations and withstand the ambient conditions of the targeted application.
- Advanced materials are needed to allow the capturing of chemical and bio-chemical signals with extended lifetime or extreme low cost for disposable sensors.
- Smart concepts and tools for evolving data analysis that embed a deep understanding of the sensor properties enable new business models for distributed, connected sensors.

Scope: Proposals should address one or several the following activities:

- Biosensors and chemical sensors can be applied to detect and monitor analytes or pathogens in the environment, health, and food industries in an efficient and timely manner. Fast scanning and sensor-based devices that can be deployed at a large scale could augment or replace traditional methods of measurement and quality control.

- Advanced biological or biomimetic sensing elements for the measurement of biomarkers allow for new compact analytical devices or be integrated in personal devices such as smart phones, smart watches, and body sensors.
- New materials with properties such as stretchability, self-healing and self-cleaning for use in wearable electronics and smart textiles enable next-generation devices for the health and sports sector.
- To enable a fast development of new advanced materials, digital tools such as modelling, simulation and characterisation techniques are under the scope, assisted by advanced methods e.g. physics-based methods, machine learning or artificial intelligence.
- Connected smart sensors allow for new data analysis concepts. Algorithms may be adapted throughout the lifetime of the deployed devices, improving their functionality through data-fusion with additional data sources, adaptation to new requirements or enabling of big-data scenarios.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

HORIZON-CL4-2023-RESILIENCE-01-34: Advanced (nano)materials for sustainable agriculture (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Chemical industries and retailers will have to innovative solutions (for agricultural practitioners) based on safer and more sustainable chemicals allowing them to reduce GHG emissions and pollution from agriculture, including risk and dependency on pesticides, excess fertilisation, reverse biodiversity loss and provide more sustainable food production.
- The next generation of fertilisers, pesticides or plant protection products will be based on new delivery systems for agriculture made from advanced (nano)material.
- The new agrochemicals will be safe and sustainable by design with GHG emissions, an improved efficiency, biocompatibility and biodegradability.

Scope: Proposals should address all of the following activities:

- Develop advanced (nano)material based delivery systems for agriculture (fertilisers, pesticides or plant protection products) complying which are safe and sustainable by design (SSbD) and smart (stimuli-responsive or driven). The developed systems should exhibit improved efficiency, biocompatibility and biodegradability to

overcome the problems of traditional agrochemicals (e.g. pest resistance, bioaccumulation in non-targeted fauna, flora, soil, groundwater, and the food chain due to uncontrollable release to the environment).

- Each proposal should identify and address at least two selected delivery systems based on SSbD (nano)materials for which they will provide safety and sustainability assessment along their life-cycle including non-target organism toxicity. The efficiency of selected delivery systems should be proven in real-life case studies. The justification for their selection should include socio-economic aspects and a gap analysis.
- The proposals should built up on existing standards where available and relevant or on specific guidance for risk assessment of selected delivery systems (e.g. on EFSA Guidance on nanomaterial risk assessment for advanced (nano)material based pesticides in Appendix D2[23]). Data produced during the development of new SSbD agrochemicals should be FAIR[24] and shared though available platforms (e.g. IPCHEM).
- Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes, clusters (e.g. Nanosafety Cluster) and platforms, in particular with European Platform on Life Cycle Assessment (EPLCA)[25].

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

International cooperation is encouraged.

HORIZON-CL4-2023-RESILIENCE-01-35: Biodegradable polymers for sustainable packaging materials (IA)

Biodegradable polymers are a part of the solution to reduce the use of plastics in the packaging industry. At present, manufacturing of plastics for packaging and bottling is largely based on petroleum-based feedstock, such as polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET), which are not biodegradable. Unrecycled plastics cause environmental pollution when ending up in landfills, or as litter in the natural environment; and cause carbon emissions when used for the generation of energy.

[23] https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2021.6768
[24] https://www.go-fair.org/fair-principles/
[25] https://eplca.jrc.ec.europa.eu/

Expected Outcome: Projects are expected to contribute to the following outcomes:

- The packaging industry will have access to the next generation of renewable and recyclable materials. Plastic materials producers will switch from PP, PE, and PET to bio-degradable materials with reduced GHG emissions.
- The packaging industry applies a business model of designed circularity for renewable and recyclable materials, and thereby supports the sustainable use of packaging materials. This leads to a reduction in landfill waste volume of packaging materials; and to a reduction of littering of plastics, coherent with the ambition of the Horizon Europe Mission on Oceans to reduce to plastic pollution of the oceans

Scope:

Proposals should address the following activities:

- Develop new advanced aliphatic polyesters (e.g. PHB, PLA, PGA, PCL, PBS and PHAs bio-degradable polymers) that can be produced at a large scale with a similar economy of scale to replace present production with PE, PP and PET.
- Developing sustainable additives and catalysts to support the production of bio-degradable polymers.
- Prove that the cost for manufacturing does not exceed 10% of the cost for manufacturing of existing products
- Scaling the production of packaging materials at pilot level.
- Develop and demonstrate a circular business model for production at industrial level, where the release of GHG emissions is minimized; andassess the potential of secondary raw materials as a feedstock for production of the biopolymers, as well as the potential of the developed biodegradable polymers as a secondary raw material for further production processes.
- Identification of the biodegradability pathways in environmentally relevant conditions (for the application of the developed material in relevant shape or form); and extensive quantified risk analysis from both a human and environmental perspective for all the different intermediate and end products of biodegradation, including quantification of the contribution to GHG emissions.
- Modelling of the lifetime of the developed polymers along the biodegradation pathway in environmentally relevant conditions, both in natural, and in waste processing environments.
- Demonstration of complete biodegradability in all relevant conditions and environmental compartments (e.g. landfill, compost site, litter in marine-freshwater-sediment-soil) within acceptable timeframes, determination of the main influencing environmental conditions; and assessment of the impact on the environment.

To enable a fast development of new advanced materials, digital tools such as modelling, simulation and characterisation techniques are under the scope, assisted by advanced methods e.g. physics-based methods, machine learning or artificial intelligence.

Currently, under the Chemical Strategy for Sustainability, the Safe and Sustainable by Design criteria are being developed. Since this topic includes the development of new chemicals, the proposal is expected to demonstrate adherence to the Safe and Sustainable by Design philosophy (anticipating any safety or sustainability issues in the production, use, or after-use phases).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects (e.g. Open Innovation Testbeds) and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

HORIZON-CL4-2024-RESILIENCE-01-36: Advanced biomaterials for medical applications (IA)

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- Medical and/or surgical procedures will benefit from injectable materials for non-invasive surgical procedures.
- Some of their advantages include easy deliverability into the body, increased implantation precision, controllable release of therapeutic agents, and the possibility of monitoring or stimulating biological events.
- Medical suppliers can commercialise injectable hydrogels, bio-ceramics and electronics.

Scope: Proposals should address one the following activities:

- To enable a fast development of new advanced novel injectable biomaterials , digital tools such as modelling, simulation and characterisation techniques are under the scope, assisted by advanced methods e.g. physics-based methods, machine learning or artificial intelligence.
- The innovation market with medical applications is fast growing and dependent on advanced biocompatible materials that can be printed or injected. The 4D materials will change their 3D structures after external impact such as thermic, electric, or radiation treatment.

- The topic has to develop new engineering strategies that present functional characteristics beyond bio-compatibility, and express properties that can be used to control the physiological environment and induce a response.
- The design for circularity has to develop bio-degradable or bio-absorbable biomaterials that are gradually eliminated by the body after fulfilling a purpose

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

HORIZON-CL4-2024-RESILIENCE-01-37: Advanced materials substituting critical raw material in applications for the new energy innovation (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Projects shall provide European industry with advanced materials solutions for the new energy innovation market, which is largely dependent at on the availability of critical raw materials.
- Europe's industry will benefit from advanced materials substituting a significant share of critical raw materials in mangets (compared to the state of art) and hence will alleviate dependency and possible supply risks and strengthen Europe's strategic autonomy and competitiveness.
- This is in particular necessary to keep up with the political ambitions of the European Green Deal matching the increasing demand for energy harvesting and storage with the ambition to reduce emissions.

Scope: Proposals should address the following activities:

- Many energy converting devices use such as electric motors and in magnets for wind and water generating turbines use rare-earth magnets.
- The likely increased need for more rare-earth magnets will stress a future demand for NdFeB magnets, which requires strategies to replace rare-earth metals such as Nb.
- Rare earth-free magnets for turbines with good efficiency levels were already developed and could be further adopted. Alternatively, the future demand for rare earths, in particular for dysprosium, could be reduced by improving material efficiency for example in wind turbines.

- In order to reducing rare-earth elements in nanocrystals and photoelectric devices, rare earth-doped perovskite manganite oxide nanostructures with a chemical composition of LnxA1-xMnO3 (where Ln represents rare earth metal elements such as La, Pr, Nd, A is divalent alkaline earth metal elements such as Ca, Sr, Ba) shall achieve similar magnetic properties such as NdFeB magnets.
- Delivering a scaling of the production of rare-earth metal free magnets at an industrial level.
- To enable a fast development of new advanced materials, digital tools such as modelling, simulation and characterisation techniques are under the scope, assisted by advanced methods e.g. physics-based methods, machine learning or artificial intelligence.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

Additionally, a strategy for skills development should be presented.

2.4 Improving the resilience of EU businesses, especially SMEs and Startups

HORIZON-CL4-2023&2024-RESILIENCE-01-41: 'Innovate to transform' support for SME's sustainability transition (CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Support objectives of the European Green Deal and of the EU SME Strategy for a sustainable and digital Europe;
- Increased resilience of SMEs, by fostering technological and social innovation in SMEs to support their transition to more sustainable business models and more resource-efficient and circular processes and infrastructures;
- Increased competitive sustainability of SMEs through the uptake of advanced technologies;
- Stronger innovation support ecosystems supporting the green, social and economic transition of SMEs, by leveraging synergies between existing EU networks and SME support initiatives.

Scope: Achieving European Green Deal objectives, and notably a climate neutral and resource efficient economy, requires the full mobilisation of SMEs. The COVID-19 pandemic has also led to companies redesigning their supply chains and facing a new industrial revolution, brought on by a new generation of advanced technologies[26], which are underpinning the potential for competitive sustainability of SMEs.

The action will build on and further connect existing EU specialised business support networks and centres – such as the Enterprise Europe Network, the European industry clusters registered under the European Cluster Collaboration Platform, Centres for Advanced Technologies for Industry. They will work in complementarity and close interaction with Open Innovation Test beds, European Digital Innovation Hubs, Start-up Europe etc., but also with academia, social partners and other social innovation actors.

This action will consist in:

A. Advisory services

[26] The Advanced Technologies for Industry project of the European Commission offers analytical overview of 16 advanced technologies: https://ati.ec.europa.eu/about/what-is-ati: *Advanced Manufacturing Technology, Advanced Materials, Artificial Intelligence, Augmented and Virtual Reality, Big Data, Blockchain, Cloud Computing, Connectivity, Industrial Biotechnology, Internet of Things, Micro- and Nanoelectronics, Mobility, Nanotechnology, Photonics, Robotics and Security.* European SMEs have shown a chronic lagging behind the US and China in the uptake of advanced technologies

Dedicated innovation and capacity building support will be provided to SMEs, to assess their ability to transform their business models and increase their resilience.

This will consist of an assessment of SMEs' innovation and sustainability practices, elaboration of recommendations, notably in view of the uptake of advanced technologies and/or social innovations.

Based on these recommendations, SMEs could receive further advisory services according to their level of preparedness such as help and advice on proof of concept, investment readiness, intellectual property (in cooperation with EU funded IP support)[27], technology transfer, adaptation to standards, adaptation to environmental rules, design management, skill development, partner search (including social partners). SMEs will receive targeted assistance for the uptake of advanced technologies.

Social innovation should be recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

This action will also include the set-up of a community, building on the SME Alliance projects, in which best practices should be exchanged and SMEs could benefit from dedicated peer-learning activities in order to learn from leaders (SMEs or larger corporates) of their own sector. Incentives for leaders to share their best practices with peers should be identified in the context of EU support to industrial ecosystems.

B. Financial support in the form of 'Third party financing'

As a result of the advisory services and initial assessments, SMEs will receive financial support through calls for SMEs, to implement the elaborated recommendations.

This should support amongst other activities the financing of a feasibility study, prototyping, pilot testing, demonstrating, procurement of further specialised consultancy services and coaching services that cannot be provided directly by the project partners, adaptation of business processes, free access and support to use testing facilities, introduction of new IT solutions etc.

The Commission estimates that at least half of the budget should be allocated to financial support to SMEs in the form of third party financing.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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[27] See ATI reports from US and China about technology performance:
China: https://ati.ec.europa.eu/reports/international-reports/report-china-technological-capacities-and-key-policy-measures ; and
US: https://ati.ec.europa.eu/reports/international-reports/report-united-states-america-technological-capacities-and-key-policy
https://intellectual-property-helpdesk.ec.europa.eu/index_en;
https://intellectual-property-helpdesk.ec.europa.eu/horizon-ip-scan_en;
https://euipo.europa.eu/ohimportal/en/online-services/ideas-powered-for-business

HORIZON-CL4-2023-RESILIENCE-01-43: Boosting generation and diffusion of advanced technologies in SMEs based on a supply chain model (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Build a model for each industrial ecosystem to identify disruptions and technological opportunities for the uptake of advanced technologies in a supply chain
- Alert on current disruptions and identify potential future disruptions
- Identify potential alternate suppliers of critical advanced technologies
- Launch one pilot project per each industrial ecosystem focused on building alliances among traditional and tech-savvy SMEs through industrial cluster organisations
- Explore concrete collaboration opportunities between different type of EU businesses, particularly tech-savvy SMEs and traditional SMEs.
- Increase the adoption of advanced technologies in traditional SMEs and help EU tech-savvy SMEs that developed critical technology applications to expand their market potential in the EU;

Scope:

All the EU industrial ecosystems should adapt to the post-crisis economic environment, with new consumer and industrial demand, changed competition and new resilience and sustainability objectives. This adaptation will be particularly challenging for SMEs. The economic recovery in Europe, after the COVID-19 pandemic, will only materialise if SMEs are properly supported by adequate actions and policy measures to adapt to changed value-chains and demand.

It is essential for companies to map their supply chain in order to identify critical dependencies and weaknesses in specific industrial ecosystem. There is a need for developing methodology or model that can assist companies in detecting and anticipating disruptions in their supply chains. Such a model would contribute to reduce strategic dependencies on critical products, services or technologies.

The operational independence that the manufacturing industry will be achieved through the adoption of advanced technologies. This operational improvement will be of paramount importance in ensuring performance during the next normal. In fact, COVID-19's impact on trade caught many firms unprepared, with negative consequences on supply chains. This event drastically changed the focus from a low-cost country sourcing mantra to a more resilient and simpler network. Implementing new technologies is turning supply chain processes and activities towards less uncertainty and complexity. Technologies like robotics, AI, IoT, blockchain, and edge computing are the key drivers to achieve these goals, together with efficiency benefits and zero-touch production (ZTP) processes, the latter being pushed significantly during the pandemic and becoming a strategic asset for the future of enterprises.

Efficiency is also fostered by AR/VR solutions, which enable experts to provide remote support to on-field operators and provide step-by-step instructions. B2B digital platforms are also a key trend in the manufacturing industry, pushing for a more collaborative relation between colleagues, peers, and employees. This opportunity is deeply connected to Big Data/analytics technology, which allows the user to track and analyse processes, improve operational visibility, and understand improvements and trends. 3D printing has shown its huge potential in creating and modifying manufacturing and healthcare products during the pandemic and is likely to be a key trend in the coming years. Product innovation is also driving the adoption of advanced materials, micro- and nanoelectronics, nanotechnologies, and photonics with the aims of improving products and reducing costs.

HORIZON-CL4-2023-RESILIENCE-01-44: Affordable Housing District Demonstrator (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Demonstrate renovation pilots in the sense of "*lighthouse districts" as announced by the Affordable Housing Initiative in the Renovation Wave communication*[28] *and the New European Bauhaus* following a smart neighbourhood approach and providing blueprints for replication, setting liveability and latest technological and social innovations at the forefront;

- Mobilise cross-sectoral industrial[29] and partnerships at local level to develop, adapt, design new processes, methods and technologies (e.g. energy efficiency, circular, modular building, smart living, eco-design etc.). Special attention should be paid to the needs of residents in social using, through social innovation and using a human centred approach;

- Following a multi-actor approach, as defined in WP/ Annex X, engaging both, different sectors and fields of operation related to construction such as renewable energy, water treatment, and electronics as well as residents, social and public housing associations and civil society actors will be key to boost tailor-made and fit for purpose innovation;

- Demonstrate through such partnerships *lighthouse districts* that allow integrated renovation approaches. Besides technological innovation, specific focus on social innovation is crucial as it can provide social engagement models to empower and engage residents, foster the co-design, co-development and co-implementation, offer spatial organisation allowing socio-economic activities and services, improve the wellbeing of citizens, and promote intergenerational and mixed forms of housing and accessible architecture open for cultural and creative innovation. Social innovation may also form a key aspect in developing business models for these types of lighthouse districts;

[28] *https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662*
[29] Refers to the 14 Industrial Ecosystems for Recovery

- Develop new bottom-up human-centred business models in housing area that facilitate engagement of residents in renovation – for example by co-investing, setting up energy communities, housing cooperatives and resident owned social services and (creative, green, …) commons;

- Identify "ready to go projects" for the *lighthouse districts* as well as "low hanging"[30] fruit in terms of social housing renovation and worst performing buildings to test new methods, practices and technologies. The selected districts/ use cases, the diverse climatic and biogeographic conditions and settlement types in urban, sub-urban and rural areas across the EU are to be well reflected;

- Support businesses and the private sector in developing demonstration projects that go the extra mile (environmental - social – cultural ambition) and allow innovations and new technologies putting inclusion and social progress at the forefront;

- Pilot circular construction methods taking into account the different industrial perspectives and value chains relevant for the renovation of the districts;

- Apply and pilot innovative smart housing applications (at individual dwelling level) and general smart grid or district-level energy, waste, water, storage and other systems using newest technology at scale as well as technology that improves the social housing service provision itself;

- Plan actions for overcoming relevant barriers for renovation at district level with a majority of social housing dwellings (e.g. regulatory limits, lack of trust amongst different stakeholders, lack of private investors and awareness of the integrated approach potential);

- Effectively disseminate major innovation outcomes established in districts to support the implementation of industrial-urban symbiosis, connection to the European Community of Practice (ECoP) and development of flexible learning resources;

- Act as a catalyst for relevant EU projects and policies and channel this intelligence towards local projects and stakeholders, e.g. active aging, smart communities, including smart cities and smart villages, energy communities, skills, etc.;

- The final objective is to obtain a set of lighthouse districts that each have followed a different approach, focussing on different innovative solutions addressing the local reality and needs and to have demonstrated replication potential towards other districts by providing blueprints for replication and adaptation and by setting up a network amongst social housing providers.

[30] Many housing blocks in Eastern Europe are at the stretch of their "expiration date" and in need of a deep renovation. They are often located in proximity of each other which makes a district approach more beneficial. Many of the flats are owned by their residents, usually with no financial resources to renovate themselves. Therefore inclusive financial programs should be developed.

Relevant indicators and metrics, with baseline values, should be stated clearly in the proposal.

Scope:

To support a wide implementation of these district renovations, industrial urban symbiosis needs to be fostered amongst most relevant partners engaged in construction and renovation of social housing facilities. The local and regional dimension is important since local energy and utility networks, adjacent industrial infrastructures and available by-products and services in such districts would have to be considered in a holistic and integrated approach. In the same way, logistics should be optimised wherever possible and should be an advantage from the sustainable and competitiveness perspective.

The scope of the project can address COVID-19 related challenges and opportunities such as reorganisation of housing areas and districts, conversion of office buildings into housing units, (inter)generational living, housing facilities addressing new work-life standards and needs, neighbourhoods driving local economic activity and new entrepreneurial opportunities, energy price shocks, increased material costs, etc.

Technology based innovations should prove the potential for novel symbiotic renovation projects acting as demonstrators involving multiple industrial sectors (combining non-exhaustively energy, construction, renewables, circular, electronics and creative industries, social housing associations and public authorities) in pilot multi-stakeholder partnerships focussing on a district approach and social needs related to social housing. Projects are expected to address:

- The development of a broader integrated methodology towards renovation of social housing districts starting from a cross-sectoral approach (e.g. INNOSUP) and engagement models of residents to develop the application of technologies that make social housing more energy efficient, accessible and liveable;
- Research how technologies for housing and renovation can be adapted in a way that serves the needs of residents in social housing at affordable cost as well as how development at scale (e.g. district level of multi-apartment building) might bring cost optimisation and improve the affordability;
- The adaptation of technology in way it addresses the basic and essential needs of residents rather than to showcase the most advanced application from a technical perspective (human centred, fit for purpose and tailor made);
- Research on how renovation of social housing districts can deliver a more balanced population in terms of income, age and socio-economic profile as well as to avoid formation of *ghetto's* on the one hand and *gentrification* on the other hand;
- Aspects of environmental friendly traffic and internet connectivity to facilitate inclusion are to be considered;

- Energy poverty issues that must be avoided as a result of the renovation. Social innovation and financial planning must ensure that the cost of living will not increase significantly for tenants and residents;

- Integration of ICT and digital tools, including smart grids, smart living applications, advanced modelling for eco-design and modular construction, to design and establish novel symbiotic interactions, data sharing and preservation of data confidentiality, as a non-exhaustive list;

- Assessment methodologies and KPIs to measure the performance of symbiosis, including environmental, economic and social impacts. Life cycle assessment and life cycle cost analysis should take into account existing sustainability standards (e.g. ISO 14000) and existing best practices;

- New skills acquisition in construction sector by piloting new technologies and processes in the renovation at district level focussing on needs in social housing;

- Development of common reporting methodologies for the assessment of industrial symbiosis activities and exchanges;

- Tools to support companies in redefining their products process and systems from the point of view of design, production, logistic and business models;

- Research on how realised lighthouse models can be duplicated and adapted to other social housing contexts, for example, where no strong social housing sectors are present or where participation models are less developed, such as energy communities and cooperatives;

- This topic supports the Bauhaus Initiative as lighthouse districts could display the application of the New European Bauhaus practices focussing on the aesthetic and co-creative aspects of renovation and building of social housing districts.

Clustering and cooperation with other selected projects under this cross-cutting call and other relevant projects as well as building on existing projects is essential, as many existing EU projects can contribute to very specific applications or process in such a district renovation.

3. Destination: World-leading Data and Computing Technologies

3.1 Data sharing and analytics capacity

HORIZON-CL4-2023[2024]-DATA-01-01: Green data operations and compliance technologies (AI, data and robotics partnership) (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- to enable companies and public sector to easily comply with emerging regulation and create value on data assets that they possess or that they acquire from the market, and to allow citizens to feel more confident that data-driven systems treat them in a fair, unbiased and compliant way and respect their privacy/anonymity and other rights, and keep track of the use of personal data in a world where "everything" moves online.
- Shorten the time-to-market and reduce development costs of compliant data solutions
- Reduce the environmental footprint of massive data operations which will contribute to the Green Deal target "no net emissions of greenhouse gases by 2050".

Scope:

Developing, piloting and integrating systems, tools and data economy enablers that process the increasing data volumes more efficiently, distil more useful knowledge from data, and reduce the large environmental footprint of massive data operations (e.g. by minimizing data transfers/traffic and/or reducing energy consumption of AI training/machine learning and other processes).

The technologies should also respond to the emerging needs for practical, affordable and automated compliance tools (e.g privacy preservation, smart contracting, consent management, tracking of uses of data etc.), as well as design principles and architectures that are inherently compliant.

The aim is to provide Common European data spaces and AI data provision with reliable mechanisms to monitor, control and track/record transactions on data, to ensure compliance.

To this end, projects are invited to employ appropriate technologies and methods, such as federated and distributed AI/analytics; protect privacy and confidentiality of AI training data and reduce energy footprint.

Proposed actions should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. In particular, they should build on the results of the Horizon 2020 data platform projects (topic ICT-13-2019) and the results of projects selected under topic HORIZON-CL4-2021-DATA-01-01.

[This topic implements the co-programmed European Partnership on AI, data and robotics]

HORIZON-CL4-2023[2024]-DATA-01-02: Integration of data life cycle, Architectures and standards for complex data cycles and/or human factors, language understanding (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- ability to process vast volumes data as one of the key enablers for other technological developments, supporting the competitiveness of the EU's industrial ecosystems;
- successful deployment of data spaces involving several sectors of economy or society;
- improve data access, data sovereignty, data interoperability and data protection as an essential factor in the development of sustainable value chains respecting all stakeholder interests, particularly SMEs, but also the public sector as data providers and innovation/market ecosystem enablers. The Data Strategy for Europe calls for actions to support and promote data sharing and the use of data for social and economic benefit.

Scope:

Proposals should address the entire data life cycle from data generation/collection to the final use and disposal/deletion of data (especially when required by applicable legislation, for example GDPR). Proposals should build on existing and emerging standards, models and architectures and complement/expand them as necessary in view of interoperability of systems and portability of data, especially between sectors, between private and public sectors and between different communities/constituencies of actors. Envisaged architectures and systems should enable correct allocation and enforcement of data-related rights, obligations and responsibilities across the life cycle. Proposals should address human needs and human factors at all stages of data life cycle, addressing the social and cultural factors as necessary. Systems and approaches should increasingly be able to understand human-generated and human-related data (e.g. speech, text, images) to better put data into context and to grasp the deeper meaning and context (including cultural, linguistic and social context). Likewise, the seamless integration of "human in the loop" (whenever full automation is not possible/desirable) should be considered and implemented where applicable.

Proposed actions should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. In particular, they should create links with the Data Spaces support centre funded under the Digital Europe programme, and work in close collaboration with the emerging Common European data spaces in order to ensure interoperability and coordination of data architectures. Research should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

3.2 From Cloud to Edge to IoT for European Data

In line with Europe's data, green and industrial strategies, for capitalising on the paradigm shift to the edge, Europe needs to pool major investments. Considering the exponential growth of connected devices and systems, data processing and analytics at the edge will become an engine for industrial transformation in key sectors. Building on Europe's industrial leadership in many sectors and in particular in the industrial Internet of Things, this trend offers the opportunity for European actors to establish a computing infrastructure which does not replace the cloud but which could strive for innovation and openness, different from today's cloud and data processing market. Leveraging the Chip Act to ensure autonomy of chip supply value chains, edge computing becomes a key driver for the chip demand in terms of next generation industrial computing fabric and system design, such as next generation on-bard compute architectures for cars, on-site factory edge, decentralised renewable integration

The next WP2023-24 targets the validation of these new paradigms, it will be on the development and adoption of baseline technologies and system concepts integrating relevant elements of computing, connectivity, IoT, AI cybersecurity. These were supported under WP 2021/22 in order to reach the next maturity stage towards further deployment. The next WP will build on European strengths in real-time systems, sensors, (industrial) IoT, system engineering, and industrial application and supports the realisation of a European computing continuum value chain from Cloud-to-Edge-to-IoT in and across key industrial sectors like mobility, logistics, energy, agriculture manufacturing.

HORIZON-CL4-2023[2024]-DATA-01-03: Piloting emerging Smart IoT Platforms and decentralized intelligence (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Implementations of edge paradigms in real environments leading to matured and customised IoT and next generation edge computing technologies for adoption in key applications and sectors.
- Paving the way to strategic industrial cooperation in data processing required to support future hyper-distributed applications by building open platforms, agreement on common architectures and standards, critical to establishing a mature European supply chain.
- Open platforms underpinning an emerging open edge ecosystem including midcaps, SMEs and start-ups that foster edge solutions, which represent a modular functional spectrum of executable apps and services critical to establishing a mature European supply chain under challenging and extremely competitive market conditions.
- Demonstrating cross-domain standardisation and up-scaling of edge infrastructure solutions

Scope:

Proposals should target up-take and up-scaling of emerging EU-driven smart industrial internet of things and edge computing systems to perform under real life conditions, as to mature particular technologies like meta-operating systems for the IoT and the Edge, cognitive cloud technologies and tools for decentralized intelligence and swarm computing for adoption across key applications and sectors crucial for Europe's competitiveness and strategic autonomy.

Such systems will create value in orchestrating multi-tiered data processing with control and automation on the edge, minimizing energy footprint, stimulating multi-sided marketplaces, and fostering open standards for virtualization, interoperability and secure and trusted data sharing between different stakeholders of the value chain – both horizontally and vertically, thereby providing an environment of multi-platform capabilities and preventing lock-in effects for users. Pilots are to implement and demonstrate mature solutions, on technology integration such as sensors, actuators, distributed control, connectivity and edge computing and embedded reasoning to demonstrate resilience and autonomy of system with low data processing latency for analytics and AI-inference and decentralised intelligence at the edge. In order to avoid concurrent solutions and fragmented standards and tools, pilots should validate cross-domain interfaces and common standards and foster cross-sector industrial agreements on architectures, design tools and governance. With the cross-domain up-take these pilots will demonstrate shorter development circles, accelerate adoption of edge infrastructure through shared cross-domain usage, especially through the creation of common management tools and standardised edge architectures

Such systems must be targeted to become open platforms underpinning an emerging open edge ecosystem including midcaps, SMEs and start-ups that foster edge solutions, which represent a modular functional spectrum of executable apps and services critical to establishing a mature European supply chain under challenging and extremely competitive market conditions

Innovation Actions are used to customise, explore the limits, test, optimise and validate emerging European smart IoT and edge computing systems under the constraints of industrial mass-market applications, by taking a system-level approach from hardware of smart devices to operating systems at device and at system level, to middleware and to application software. in particular, for real-time applications such as mobility, manufacturing, condition monitoring/predictive maintenance, energy, and farming, and avoid vendor lock-in. Pilots are expected to address more than one application domain.

Pilot projects are expected to contribute to the coherence/cluster work that will be implemented by the CSA supporting the activities defined under ""Horizontal Activities"" below. This requires that they contribute to clustering their results of horizontal nature (interoperability approach, standards, security and governance approaches, validation of emerging business models for an emerging IoT/edge infrastructure and sustainability, methodologies, metrics, etc.).

HORIZON-CL4-2023[2024]-DATA-01-04: Cognitive Computing Continuum: Intelligence and automation for more efficient data processing (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Enhanced openness and strategic autonomy in the evolving data economy across the computing continuum including adapted system integration at the edge and at device level, validation of key sectors and nurturing European value chains to accelerate and steer the digital and green transitions.
- Paving the way to strategic industrial cooperation in data processing required to support future hyper-distributed applications by building open platforms, underpinning an emerging industrial open edge ecosystem critical to establishing a mature European supply chain.
- Establishment of adaptive hybrid computing, cognitive clouds and edge intelligence beyond today's investments on data infrastructure.
- Better international collaboration with trusted partner regions, guaranteeing a minimum level of interoperability, portability thereby fostering competition in the Cloud/Edge services market for the European cloud/edge and software industry and facilitate European access to foreign markets.

Scope:

The Cloud-Edge Continuum must provide seamless management schemes to allow services and data to be processed across various providers, connectivity types and network zones. This requires innovative management techniques of the whole computing continuum from Cloud to Edge to IoT that are enabled by Swarm computing and decentralised intelligence.

It involves hyper-distributed computing approaches encompassing resources from IoT and far-edge constrained devices, to federated fog/edge computing nodes to central cloud computing centres and hybrid cloud models which exploit Artificial Intelligence techniques to advance automation and dynamic adaptation of resource management in Cloud and Edge systems, and thus intelligently balance computing tasks across decentral and central computing environments to optimize resources and quality of service. Focus must be on autonomous and AI-enabled management schemes that enable this transition to a compute continuum with strong capacities at the edge and fog/IoT edge in an energy efficient and trustworthy manner. Intelligent compute, data and code orchestration mechanisms need to integrated, which allow efficient value extraction from the huge volumes of generated data at the edge of the network and which support unprecedented levels of resource dynamicity and scalability across the compute continuum.

Concept should cater for novel automated management tools, programming models and approaches able to cope with end-to-end security and identity management, resources heterogeneity, extreme scale and fault-tolerance together with elasticity to flexibly allocate resources and tasks. For security and identity management, proposals are expected to develop

synergies and relate to activities and outcomes in Cluster 1 and Cluster 3 related to privacy and online identity management.

Resource heterogeneity should consider the diversity of devices equipped with storage and processing capacities at the Edge and their specific characteristics, but also the increasingly available variety of processor architectures for these devices, including where possible, emerging open solutions (e.g. RISC-V).

In addition, it should incorporate tools and mechanisms enabling the optimisation of energy efficiency and ecological sustainability taking into account end-to- end data processing across the continuum. Interoperability approaches (based on open standards, interoperability models and open platforms) should be considered where appropriate.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

International cooperation is encouraged, especially with Japan and S. Korea.

HORIZON-CL4-2023[2024]-DATA-01-05: Platform Building, standardisation and Up-scaling of the 'Cloud-Edge-IoT' Solutions (Horizontal Activities - CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Supporting the Commission and the constituency in coordinating the proposal portfolio in particular resulting from HORIZON-CL4-2023-24-DATA-XX, and ensure consistent exploitation of the outcomes.
- Alignment with national or regional initiatives will create an expanding innovation eco-system, anchored in local contexts across Europe.
- Underpinning an emerging open edge ecosystem including midcaps, SMEs and start-ups, critical to establishing a mature European supply chain
- Outcomes are expected to accelerate the pick-up of novel advanced edge technology in most important sectors for Europe's economy, and competitiveness as well as an analysis of cross cutting aspects like open standards, open source, and synergies across sectors.

Scope:

CSA actions provide consistency and linkages between the pilots and complement them by addressing horizontal challenges critically important for the take-up of edge computing at the anticipated scale. Support programme implementation across projects and topics in the area of Cloud-Edge-IoT, especially foster consensus on interoperability and standards as well as

ecosystem building in and across verticals, an environmental and green impact. The CSA will ensure an efficient interplay of the various elements of computing, network connectivity, AI and learning, etc. establish a concept through a forum to link to relevant European and national initiatives and partnerships and add value by active cross-fertilisation across academia and industry and sectors, . A fertile communication strategy for broader stakeholder engagement is expected. Concrete activities will include trend scouting, portfolio analysis, a variety of participatory workshops, analysis of emerging business cases, accelerator of technology up-take and promotion of open calls.

[*A concept to create and catalyse an industrial forum for emerging edge computing and decentralised intelligence concepts and socio-economic trends. These actions will help industry to navigate rapidly changing market environments, to dynamically adapt to dynamic industrial context to prioritise strategic directions of the pilots and accelerate adoption of mature technologies*.]

Better international collaboration with trusted partner regions, guaranteeing a minimum level of interoperability, portability thereby fostering competition in the Cloud/Edge services market for the European cloud/edge and software industry and facilitate European access to foreign markets

Multidisciplinary research activities should address [one / at least one / all / some] of the following:

- Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH), in particular in …, to achieve … (please also set out the aims of such SSH involvement as an expected outcome).
- Activities should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.
- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.
- International cooperation is encouraged, especially with US.

HORIZON-CL4-2023[2024]-DATA-01-06: Coordination and Support of Cognitive Computing Continuum research and policy (CSA)

Expected Outcome: Proposal results are expected to contribute to the following expected outcomes:

- Support structure for the European Computing ecosystem: networking events and vision workshops for the academic and industrial computing community,
- Yearly updated roadmaps on the computing continuum addressing the area from a broad perspective from edge device to edge cloud to cloud to HPC, from scientific to industrial

to societal and research applications, and addressing all relevant aspects such as real-time, security, etc. Developments should complement the Industrial Roadmap from the European Alliance for Industrial Data, Edge and Cloud by offering a long-term research perspective which enables disruptive innovations.

- Creation of a sustainable European forum of stakeholders representing the whole Cloud to Edge to IoT Computing research, industry and users.

Scope:

To support the European Commission and the European computing constituency by providing to them annually updated roadmaps for research and innovation.

Facilitate awareness of stakeholders in research and policy matters related to Cloud-Edge-IoT Computing continuum.

Coordinate stakeholders in the Cloud to Edge to IoT Computing Continuum and act as support to R&D programmes/activities by disseminating project results and organising scientific and policy events, and addressing pre-standardisation initiatives.

International cooperation is encouraged, especially with Japan, South Korea.

HORIZON-CL4-2023[2024]-DATA-01-07: Collaboration with NSF on fundamental research on new concepts for distributed computing and swarm intelligence (CSA)

Expected Outcome: Proposal results are expected to contribute to the following expected outcomes:

- Support structure for EU-NSF cooperation: networking events and vision workshops for the academic and industrial computing community,

Scope:

E4 and the relevant entity at US National Science Foundation (NSF) have identified mutual interest in collaborating on longer-term fundamental research on new concepts for distributed computing and swarm intelligence. In a recent joint event session with 2 experts from each side of the Atlantic, common needs emerged on managing complexity through high levels of abstraction, in particular related to large numbers of distributed objects, evolving computational capacity at the edge, new AI-based concepts leading to self-organised, dynamic, and adaptive management.

It is planned to further investigate the potential for collaboration in the first half of this year through a common on-line workshop. Collaboration is envisaged along the following lines:

- Common workshops for exchange of research results organised through the HIPEAC CSA under Horizon Europe Cluster 4 “From Cloud-to-Edge-to-IoT for European Data”.

- NSF would provide supplement of funding for to drive joint research.

- We encourage collaboration under WP 2023/24 in the area of “From Cloud-to-Edge-to-IoT for European Data” through a CSA for networking, research exchange, workshops, etc. Also running projects in the above area (and beyond) could consider collaboration in the case of clearly identified mutual benefit.

Due to the current competitive position between world regions, for Europe it is critical here that collaboration is limited to pre-competitive research by universities and research establishments.

4. Destination: World-leading Data and Computing Technologies

4.1 Open Source for Cloud/Edge Digital Autonomy

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01: Open Source for Cloud/Edge Digital Autonomy (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Emergence of a new distributed computing ecosystem based on open source hardware architectures such as RISC-V
- Prototypes of new computing architectures demonstrated in a relevant environment ready for adoption in distributed computing and allowing Data centre deployments fully-based on European technology.
- Adequate tools to foster European development of computing modules missing European technological alternatives.
- Foster capabilities of Open Source platforms in Cloud/Edge service provisioning.
- Increasing European autonomy by establishing the European supply and value chains in the computing continuum from the hardware infrastructure to the application level.

Scope: Proposals should

- Develop adequate tools to foster European development of computing modules missing European alternative including relevant EDA tools.
- Facilitate the emergence of European alternatives for computer modules where Europe is not digitally autonomous
- Integrate new processing architectures with existing relevant industry standards
- Demonstrate actual systems in Data center operational environments with deployments providing cloud/edge services (including relevant layer-7 internet services, e.g., HTTP, HTTPS, SMTP, IMAP, POP3, DHCP, DNS…) exploiting the benefits of the existing open source stack (kernel to application) over Open Source processor architectures (e.g. RISC-V).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Additionally, a strategy for skills development should be presented, associating social partners when relevant.

Research should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-02: Public recognition scheme for Open Source (CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Establishment of a system of European annual awards that acts as a spotlight stirring up contributions to Open Source Software and Hardware projects.
- Increased interest for the contribution to, integration of and exploitation of Open Source assets

Scope: The action should first develop a scheme including a list of fields related to Open Source. An indicative but non-exhaustive nor obligatory list of topics could include deep contributions to kernel code, brilliant utilization of open source in companies new developments…. The action should elaborate an adequate process to

- scrutinize different fields of action relevant to open source
- select appropriate candidates for being recognised
- implement adequate award ceremonies

Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH), in particular in sociology and human behaviour, to achieve a wider interest in the efficient exploitation of available open source assets.

Proposals submitted under this topic should include an exploitation strategy, as outlined in the introduction to this Destination, which allows recurrent awards.

Additionally, a strategy for skills development should be presented, associating social partners when relevant.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes.

4.2 European Innovation Leadership in Photonics

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01-photonics01: Pervasive photonics - multi-technology integration for digital infrastructure, sensors and internet of things (RIA)

The call addresses multi-technology integration of photonic functions for multiple application domains, including digital systems (computing, communications), sensor systems, robotics, automation, security and defence

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Improved key metrics for communications (speed, power consumption, density), making photonics ubiquitous in digital systems
- New capabilities for sensors and photonic-enabled computing, not feasible with single technology, enabling new systems architectures (e.g. neuromorphic computing)
- Vital contribution to Technological Sovereignty, Green Deal, Digital Transformation and Competitiveness, enabling new functionality, higher performance, more cost-effective systems across multiple application domains
- Market expectations follow and will accelerate overall trends for digital systems (computing and communications), autonomous systems, Internet of Things
- Enables strong European position to be maintained in the face of strong global competition

Scope:

Proposals should address the following:

- Co-integration of photonics and microelectronics on single or multiple die ('chiplet' approach)
- Co-integration of multiple photonic IC technologies to address new wavelengths and sensor functions
- Applications in computing, communications, robotic and autonomous systems, sensors, Internet of Things

This topic implements the co-programmed European Partnership Photonics.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01-photonics02: Advanced imaging and sensing technologies (IA)

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- The development of next generations sensory systems based on photonic technologies,
- The technological independence in sectors which involve very large worldwide markets and in which, until now, Europe has held a leading role,
- Technology leadership in autonomous vehicles, robots and sensory systems; Growth in a number of strategic industries such as medical devices, automotive, manufacturing, agriculture & food, security of large added value which are in Europe.
- Contribution to the Digital Green deal policy and to the technological sovereignty of Europe.

Scope:

Innovative hardware and software approaches, or to explore novel techniques with potential to outperform the current standards.

The projects will demonstrate the technology in the form of complete function (or building blocks) showing feasibility for future industrialisation.

It will address the following sectors:

- Automotive, where detection of pedestrians, obstacles and other vehicles at long distance is required in order to safely prepare the reaction of the vehicle in all weather conditions;
- Defence and security, where fast reconnaissance and identification of collaborative or non-collaborative targets is required for defence missions and surveillance of infrastructures;
- Industry, where long-range imaging can be used for logistics and inspection and analysis of safety and quality control of processes or produced goods;
- Health, where non-invasive spectroscopic and biophotonic imaging techniques enable diagnosis, screening, monitoring and treatment of a patient, preferably with augmented reality (AR) visualization;
- Agriculture and food, where spectroscopic imaging enables non-destructive measurement/monitoring of plants and crops and plant nutrients during production and post-harvest (e.g., phenotyping); this allows fast interactions/adjustments and enables monitoring of plant materials and food products along the entire production chain for quality and safety aspects.

Technologies covering more than one application sectors above would be encouraged, such as:

- Long range, high speed, eye-safe imaging for automotive, defence, and industrial systems
- Imaging in presence of obscurants for medical, automotive, manufacturing, agriculture, food and security

Spectroscopic imaging for medical, environmental, agriculture, food monitoring and defence.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01-photonics03: Versatile light sources and systems as tools for manufacturing and medical application (RIA)

Expected Outcome: Projects are expected to contribute to at least one of the following outcomes:

- Outcome 1: Increased manufacturing productivity;
- Outcome 2: Increased accuracy and reduced feature size in microelectronics production for the integration of photonic and electronic functionalities on chips;
- Outcome 3: Increased specificity of diagnosis of human tissue and specific cells.

Scope:

Proposals should address new versatile light sources and lasers, concept and systems for extended and new fields of applications. Research challenges include:

- Sources with multi-specification / multi-application potential;
- Extended or new wavelength ranges, novel coherent sources;
- Flexible and variable energy deposition (e.g. material processing, medical diagnosis) ;
- Versatility by spectral tuneability, coherence and multi-wavelength emission;
- Versatility by flexible pulse shapes, repetition rates and intensities (cw down to fs and bursts);
- Laser concepts and systems for multiphoton microscopy, spectroscopy and imaging.

The results and benefits of the developed technologies should be demonstrated in at least two realistic use cases.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This topic implements the co-programmed European Partnership Photonics.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01- photonics 04: Smart photonics for joint communication & sensing and access everywhere (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Sensors/probes to monitor the quality of the communication network and of photonic signals transported in the communication network
- Methods to use the network as large-scale distributed sensor
- Development of foundational optical technologies, systems and networks that provide the future access infrastructure

Scope:

Proposals should address the following:

- Light-based solutions to let the communication network sense, while transporting data:
    - To enhance the security and resilience of the network
    - To make network resources more energy efficient
    - To warn and protect against natural disasters, earthquakes etc.
    - To monitor the infrastructure where the fibre is deployed (traffic, stress in bridges…)
- Light-based solutions to bring internet everywhere, with the most relevant access technologies
    - Fiber to the home, fiber to the antenna, fiber to the sky (satellite) for ecxample with coherent passive optical networks, free space optics, Lifi, optical beamforming and steering
    - while enabling the integration of all access technologies in one system

This topic implements the co-programmed European Partnership Photonics.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01-photonics 05: Photonics Innovation Factory for Europe (IA)

Projects are expected to contribute to the following outcomes:

- Substantially improved penetration of core photonics technologies into multiple end-user application domains and industry sectors, in particular through carefully selected SMEs and new start-ups with the strongest potential for high impact in terms of business growth and employment, enabling a demonstrably more competitive and technologically sovereign European industry.
- Creation of a sustainable streamlined ecosystem for photonics innovation in Europe from TRL3-8, providing European Cross-Border Added Value with a high leveraging effect on investments made at national and regional level in photonics.

Scope:

The aim is to provide a virtual factory with a flexible and open structure, allowing for a multiplicity of competitive actors and services operating as a sustainable fully integrated European ecosystem of cross-border deep innovation support in core photonics technologies for the benefit of European industry. The factory should lower the entry threshold to photonics and facilitate the broad uptake and integration of these technologies in new products and processes with high potential impact in the market and on society.

Help speed up the deployment of proven photonics technologies within European industry in order to increase its global competitiveness, with an emphasis on technological sovereignty and resilience while also fostering strong new enterprise business growth.

Proposals should address the following:

A streamlined virtual access, supported through a network of competence centers acting as a single consortium, to a supply chain offering the broadest range of photonics technologies that cover the entire photonics innovation spectrum from concept to commercialization (TRL3-8).

The action should create pathways from initial concept through to production, employing scalable manufacturing methods connected to pilot lines and pre-series production facilities appropriate to the market, and thereby closing the gaps in photonics value chains and unlocking investments in European manufacturing based on more complete and mature solutions.

The action needs to target primarily first users and early adopters enabling the wider uptake and deployment of core photonic technologies in innovative products and processes with strong commercial potential.

Support cases must be innovative and industrially relevant, requiring intensive cross-border collaborative expert intervention to overcome specific innovation challenges based on synergetic photonics core technologies, and should include business-related coaching

activities directly linked to the innovation activities to support industrialization steps to full commercial launch as a complete value chain appropriate to the market needs.

The action must build on relevant previous European initiatives and existing infrastructure at European and regional levels, use a proven Quality Management and Impact Measurement Framework for the direct innovation support interventions, demonstrate a record of accomplishment in supporting industry, in particular SMEs and start-ups, with deep cross-border innovation support.

The action should provide strong linkages with established European Photonics industry and investment networks such as the Enterprise Europe Network, as well as (pan-) European Digital Innovation Hubs and cluster organizations in both the photonics and photonics-enabled application domains.

The action should address innovation-readiness support in the form of Demo Centers and Experience Centers to help prepare business cases plus additional supports such as technology, business, investment, and intellectual property coaching aimed at maximizing the potential future commercial impacts from the innovation support activities. The action must also be capable of demonstrating a strong business plan towards durable funding and sustainability of its activities.

HORIZON-CL4-202xx-DIGITAL-EMERGING-01-01-photonics 06: Photonic Strategies and Skills Development (CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Reinforced value chains and deployment of photonics technologies by stronger cooperation of photonics stakeholders, clusters and end-users (sub-topic 1);
- Increased competitiveness of the European photonics sector and improved access to finance for the photonics sector in Europe (subtopic 1);
- More and better prepared professionals in the photonics sector (subtopic 2).

Scope:

Proposals should address one of the following dimensions:

Supporting the industrial strategy for photonics in Europe: the objective is to support the development and implementation of a comprehensive industrial strategy for photonics in Europe. The action should include the development of strategic technology road-maps, strong stakeholder engagement (in particular Photonics21 stakeholders, National Technology Platforms, regional Clusters, end-user industries), coordination of regional, national and European strategies and priorities, fostering collaboration with other European Partnerships to identify synergies and fields of common interest, and fostering strategic collaboration with

financial institutions to improve financing conditions for Photonics industry, e.g. loans for growth financing, Venture Capital.

Fostering careers in photonics: the objective is to reach out to STEM graduates/PhD students and young postdocs in order to encourage more of them to pursue a career in photonics. Actions should help make students more industry ready and should provide the appropriate training, encourage innovation and entrepreneurship. Gender issues must also be addressed.

Up to one proposal will be selected for each of the dimensions.

This topic implements the co-programmed European Partnership Photonics.

Note: The ideas of topics below seem to display synergetic potential for joint approaches with sectorial clusters. Discussions are starting to explore the feasibility and relevance of joined work. At this stage, the current elements are still presented below for awareness and early feedback but may evolve according to cross-cluster discussions.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01-photonics07: Advanced Photonics for Health Care (IA)

Projects are expected to contribute to the following outcomes:

- The instruments must be based on existing technology or methods (TRL 4) and be advanced to TRL 7
- Point-of-Care (PoC) devices should allow either a continuous monitoring or a fast check of health parameters derived from the quantitative evaluation of certain components of body liquids or tissues.
- Biophotonic imaging systems should allow an imaging-based diagnosis, screening, monitoring and treatment of a patient, preferably with augmented reality (AR) visualization.
- Increased European competiveness in the biophotonic areas and more effective medical interventions and treatments.

Scope:

Due to the increasingly ageing society, there is a need to further develop new instruments, tools and technologies for diagnosis and treatment as well as prevention of diseases. The instruments should screen for risk-assessment and/or treatment response in certain cancer types, cardiovascular diseases, infectious diseases (rapid pathogen identification and antibiotics resistance determination) and non-curable diseases like Alzheimer's and dementia.

The instruments are (i) health care devices for PoC, (ii) Biophotonic imaging systems.

Physicians/clinicians/surgeons and a medical equipment manufacturer must be closely involved from requirement specifications to validation in clinical settings. Validation should take gender specificities into account. Clinical trials are excluded. Proposals must include an initial business plan.

Proposals should address the following:

PoC devices should be compact, cost- and energy-efficient, fast/real-time, sensitive and reliable. Instruments and analysis algorithms, including artificial intelligence approaches, for the analysis of tissue morphology and molecular composition (for example water, lipids, collagen content, etc.) or detection of already identified biomarkers in body liquids may be in the focus of the developments.

Biophotonic imaging systems need to provide imaging with a wide range of parameters from thins sections via bulk tissue towards organs with a high spatial resolution (down to a cellular level) to display the morphochemistry in real-time to allow for immediate clinical interventions. Here, single imaging modalities or the combination of different imaging modalities like e.g. fast morphological imaging in combination with slower more chemically selective imaging is envisioned. Single imaging systems must be designed to provide the option to be combined and compatible with other imaging tools. In addition the researched imaging approaches need to be also compatible with novel or state-of-the-art devices to remove pathological tissue for precision surgery (e.g. robotic surgery). All components of the final device, e.g. a surgical microscope or an endoscope, need to be compact and integrated into the workflow of an operating theatre.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01- photonics 08: Green and efficient lighting for future mobility (IA)

The call addresses photonic solutions for increased visibility and cooperative visual communication between vehicles and other road users in the automotive domain

Expected Outcome: Projects are expected to contribute to the following outcomes:

- CO2 reduction: Reduction of power consumption while increasing resolution of matrix light
- Safety Information projection promotes ‘eyes on the road’ in critical situations
- Foster cooperative driving by communicating insight of driver state and intent to other road users
- Improve traffic flow, reduce congestion
- Standards and evaluation tools for cooperative symbols and signage

Scope:

Proposals should address the following:

- Low-energy consuming light emitters to contribute to safe, secure and "Green" mobility in Europe. Applicable to both autonomously and analogue driven vehicles. Efficient usage of resources by saving energy (min. 30% energy savings vs. SoA automotive high-end LED headlights) and providing enhanced safety in all traffic conditions by e.g., sensing-enabled prevention of accidents and improved illumination of various traffic scenes.
- Efficient integration of lighting components, systems, and platforms at large manufacturing scales to be ready for high volume, cost-driven industries such as automotive. Such demands require strict quality assurance and cost control for the successful introduction in the market at the pace required by the current technological change.

This topic implements the co-programmed European Partnership Photonics.

4.3 AI, Data and Robotics

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01: Novel paradigms and approaches, towards AI-driven autonomous robots (RIA)

Expected Outcome: Projects are expected to contribute to the following outcome(s):

- Step change in autonomy of robots including Human-Robot interaction and robots acting in isolation demonstrated in key high impact sectors (e.g. healthcare, agrifood/agriculture, etc) under realistic settings.
- Step change in enabling conditions essential for the diffusion of robots in various industries, sectors and services which can either 1) handle tasks (semi-)autonomously, and safely, for a sufficiently long period of time and 2) interact safely and smoothly to support humans in their daily activities, based on strong multidisciplinary approach, including the relevant SSH dimension.
- Major advances in science and technology, to maintain Europe's scientific excellence and ensure sovereignty of these key technologies expected to affect the society in contributing to addressing major societal challenges.

Scope:

Addressing major societal challenges accelerate the need for advanced robotics solutions – such as increasing lack of caregivers to take care of constantly rising numbers of elderly people, shortage of manpower in industry, environmental challenges such as waste management, circular economy, local production and more environmentally sustainable

agriculture. High autonomy is required as robotic systems are expanding from traditional sectors to new applications where the environment is not as predictable, which requires robots to adapt dynamically by addressing these cognitive aspects.

Currently the level of autonomy of most robotics systems is a major obstacle to the wide-scale deployment of robots with advanced capabilities in many real-world applications. Most robots still require an important level of human supervision[31]. However, in many useful applications, the robots needs to work autonomously to perform the desired tasks. Recent advances in AI, Data and Robotics technologies bear promising results, especially in adopting a multidisciplinary approach, exploiting the latest results from underlying disciplines. However, more substantial research is needed to guarantee faster progress towards more autonomous robots. Substantial efforts in novel research approaches are required, exploiting latest results from sensing on the robots but also in the smart environments they evolve in, as well as advances in AI/learning approaches, including cloud robotics sharing knowledge, exploitation of all sources of data and knowledge, to improve their perception, environment awareness, anticipation of their environments and the consequences of their actions, all contributing to make robots more cognitive, improve their decisions, actions and robustness, all contributing to increase their level of autonomy. Multidisciplinary approaches are needed to integrate these various technologies and disciplines to create the next generation of robots with advanced capabilities.

Proposals will need to address safety and security aspects at all levels, as well as consider the handling of data collection (respecting relevant regulation such as the GDPR and the revised Machinery Directive)

Proposals should address several of the following aspects:

- Long-term autonomy of behaviour and energy (including frugality in terms of energy, lower environmental footprint, using new material, designed to be recycled or easily repaired etc.)
- Autonomy and adaptability in dynamic environments
- Robust and safe autonomy, including error detection, fault tolerance and recovery mechanisms, self-adaptation, also for collaborative robots
- Manipulation of heavy or large parts, manipulation of tiny objects with advanced level of autonomy
- Advanced autonomy in navigation (in all environments, and all sizes of robots).
- Automation of series of unit tasks/integration of modular/reconfigurable robots
- With/without communication channels to other systems or central control units

[31] Levels of Autonomy for Field Robots — EarthSense

- Improved HRI and natural interaction as part of autonomous behaviour

Multidisciplinary research activities should address all of the following:

- Proposals should involve appropriate expertise in all the relevant disciplines, such as engineering, computer sciences, mathematics, Social Sciences and Humanities (SSH), biology, etc. SSH is particularly relevant in addressing aspects related to the human-robot interaction and handling of data collection, to achieve usability, trustworthiness and adoption of the developed solutions.

- It is essential that scientific and technological results are reproducible and re-usable in order to contribute to the advancement of the targeted research area.

- S&T progress should be demonstrated through use-cases with major and broad socio-economic impact.

- End-users should be involved to set the requirements for the targeted sectors and/or use-cases that will be translated in technological challenges to be addressed in the projects.

- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes.

- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-01: Novel paradigms and approaches, towards AI-powered robots– step change in functionality (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Step change in functionality of robots (e.g. navigation/manipulation/interaction) demonstrated in key high impact sectors (e.g. healthcare, agrifood/agriculture, etc.) under realistic settings.

- Step change in enabling conditions essential for the diffusion of robots in various industries, sectors and services which can either 1) handle tasks efficiently, stable, and safely and 2) interact naturally and smoothly to support humans in their daily activities, based on strong multidisciplinary approach, including the relevant SSH dimension. Major advances in science and technology, to maintain Europe's scientific excellence and ensure sovereignty of these key technologies expected to affect the society in contributing to addressing major societal challenges.

Scope:

Robotics will be used and deployed to perform new activities in physical interaction with the real world (in high impact sectors such as healthcare and all critical industrial sectors for Europe, which need such robotics progress to maintain their leadership and are essential for European sovereignty). This requires to improve and expand the range of existing and applicable functionalities, in particular, interaction in real-world environments requires the robots to improve their navigation capabilities (underwater, on the ground, in the air, in the body, in areas difficult to reach, on rough terrains, in unpredictable environments, in areas including people or other moving agents, etc.), the manipulation functionalities (of very large, or heavy objects or very tiny object, or deformable objects, delicate objects, requiring advances for instance in precision, force, speed, re-planning, grasping, manipulation (including bi-manual), etc.), interaction capabilities (intuitive, adaptive, safe and natural interaction with people, or with other robots, with the environment, adapting to the variation of the environments, the needs and moves of the users, etc.). These advances still require especially integrating the latest results from data and AI technologies, to advance the perception and cognition capabilities to understand their environments, and be able to plan their actions to achieve their objectives. Research into novel research approaches, exploiting latest results from new material, advanced actuation (e.g., small-scale robots, large-scale mechatronics, soft robotics, reconfigurable robots, underactuated robots, etc.), sensing and chips (edge computing), batteries, but also AI/learning approaches, including cloud robotics sharing knowledge, digital twins, and integration of Robotics in smart environments, to improve their perception, robustness and adaptivity. Multidisciplinary approaches are needed to integrate these various technologies and disciplines to create the next generation of robots with advanced capabilities.

Proposals will need to address safety and security aspects at all levels, as well as consider the data life cycle in line with GDPR.

Multidisciplinary research activities should address several of the following:

- Robust perception, integration of sensing into mechanics

- Advanced safe and reliable navigation functionalities, integrating anticipation, re-planning, high-level goal optimisation. Natural human-robot interaction functionality
- Advanced cognitive capabilities, integrating any type of learning (from experience, human to machine learning, frugality in terms of data, unsupervised, etc.), modelling, reasoning, introspection, etc.
- Specific components / subsystems, with clear links to potential application areas addressing the biggest challenges, including miniaturized components and systems
- Novel design approaches, e.g. soft robotics, under-actuated, miniaturized, self-constructing modular/reconfigurable, robots, e.g. for navigation/manipulations in places hard to reach
- Mobile manipulation, natural manipulation of arbitrary objects including soft, fragile or other objects complex to handle
- Advanced navigation/manipulation in extreme environments (extremely small and precise in the body, autonomous navigation in the water, field robotics in harsh environments, extremely large/heavy objects, etc.)
- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

Proposals should involve appropriate expertise in all the relevant disciplines, such as engineering, computer sciences, mathematics, Social Sciences and Humanities (SSH), biology, etc. SSH is particularly relevant in addressing aspects around the human-robot interaction and handling of data collection, to achieve usability, trustworthiness and adoption of the developed solutions.

It is essential that scientific and technological results are reproducible and re-usable in order to contribute to the advancement of the targeted research area.

S&T progress should be demonstrated through use-cases with major and broad socio-economic impact.

End-users should be involved in the design process to set specifications for the targeted sectors and/or use cases.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02: Industrial leadership in AI, Data and Robotics enabling the green transition (AI Data and Robotics Partnership) (IA)[32]

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Validate AI, Data and Robotics at scale by demonstrating the potential of integrating these technologies to address challenges in key industrial ecosystems and develop solutions that are environmental friendly and contribute to the green deal
- Major advances in technology, to maintain Europe's excellence and ensure sovereignty of these key technologies expected to affect the society in contributing to addressing major societal challenges.
- Boost the innovation potential for wide uptake of AI, Data and Robotics for environmental sustainability

Scope: Proposals should demonstrate the added value of integrating AI, Data and Robotics technologies through large-scale validation scenarios reaching critical mass and mobilising the user industry, while demonstrating high potential impact contributing to the European Green Deal objectives. Focus should be given on attracting new user industries, to boost the uptake of AI, Data and Robotics in major sectors and stimulate the involvement of end-users where appropriate. Besides major industries, these Actions should also involve SMEs and/or startups with big potential to foster innovation by supporting high-tech startups. Focus will be on the most mature and promising sectors that can contribute to the green revolution (e.g. agri-food, utilities/waste-management, production/retail).

Proposals should target sectors and application domains with wide-scale deployment potential and maximum contribution to the green deal.

Multidisciplinary innovation activities should address one of the following:

- Development of innovative solutions to address major application-driven challenges, involving a large set of SMEs/ midcaps developing innovative solutions to boost the innovators community in Europe. This action will also aim to expand the robot operating system (ROS) industrial community in Europe and to expand the number and variety of

[32] https://www.europarl.europa.eu/RegData/etudes/STUD/2021/662906/IPOL_STU(2021)662906_EN.pdf

modules shared in ROS, fostering the vast deployment of such technologies in the targeted application sector and beyond.

- Large scale pilots bringing major industries from key application sectors in Europe – facilitating collaboration between these major companies and innovative SMEs/Start-ups/academia/tech-transfer organisations with the goal is to exploit tools and solutions re-usable in various use-cases/sectors (showing scalability/versatility, and allowing economies of scale)

- Proposals should involve appropriate expertise in all the relevant disciplines, such as engineering, computer sciences, mathematics, Social Sciences and Humanities (SSH), biology, etc. and involve the relevant expertise to address the environmental dimension.

- Security, privacy and safety should be taken into account to minimise risks to users and the environment.

- Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-02: Industrial leadership in AI, Data and Robotics enabling the green transition - *complementary sectors and applications*[33] (AI Data and Robotics Partnership) (IA) [34][35]

Expected Outcome: Projects are expected to contribute to the following outcomes:

[33] In the course of the preparation of the Work Programme, the AI, Data and Robotics PPP will provide the relevant input on which sectors to be addressed in topic HORIZON-CL4-2023-DIGITAL-EMERGING-01-02. This topic will complement those sectors with other promising and mature sectors.

[35] https://www.europarl.europa.eu/RegData/etudes/STUD/2021/662906/IPOL_STU(2021)662906_EN.pdf

- Validate AI, Data and Robotics at scale by demonstrating the potential of integrating these technologies to address challenges in key industrial ecosystems and develop solutions that are environmental friendly and contribute to the green deal

- Major advances in science and technology, to maintain Europe's scientific excellence and ensure sovereignty of these key technologies expected to affect the society in contributing to addressing major societal challenges.

- Boost the uptake of AI, Data and Robotics for environmental sustainability.

Scope: Proposals should demonstrate the added value of integrating AI, Data and Robotics technologies through large-scale validation scenarios reaching critical mass and mobilising the user industry, while demonstrating high potential impact contributing to the European Green Deal objectives. Focus should be given on attracting new user industries, to boost the uptake of AI, Data and Robotics in major sectors and stimulate the involvement where appropriate of end-users. These Actions should involve SMEs and/or start-ups with big potential to foster innovation by supporting regional eco-systems of high-tech start-ups. Focus will be on leveraging and nurture emerging collaborations between stakeholder communities shaping an effective eco-system fit for the challenge of European AI, Data, Robotics, and on accelerating European R&I through structural involvement of innovative SME and deep-tech start-ups.

Focus will be on the most mature and promising sectors that can contribute to the green revolution and not yet covered in topic HORIZON-CL4-2023-DIGITAL-EMERGING-01-02 (e.g. inspection and maintenance, energy, transport and construction).

In order to guarantee security and privacy of the developed solutions, proposals are expected to take into account wherever possible *green* techniques for security and privacy.

Proposals should target sectors and application domains with wide-scale deployment potential and maximum contribution to the green deal.

Multidisciplinary innovation activities should address one of the following:

- Development of innovative solutions including a large set of SMEs/ midcaps developing innovative solutions with the aim to expand the robot operating system (ROS) industrial community in Europe and to expand the number and variety of modules shared in ROS.

- Large scale pilots bringing major industries from key application sectors in Europe – facilitating collaboration small and large companies with the goal is to exploit tools and solutions re-usable in various use-cases/sectors (showing scalability/versatility, and allowing economies of scale)

- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach

to AI. Ethics principles needs to be adopted from early stages of development and design.

Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

4.4 Graphene: Europe in the lead

HORIZON-CL4-2024-DIGITAL-EMERGING-01-31: pilot line(s) for 2D materials-based devices (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Broadly accessible pilot line(s) fostering the creation of electronic and photonic devices and systems (co-)integrating 2D materials (2DM).
- Significant progress towards the adoption of the 2DM in the silicon and semi-conductor arena by allowing the production of new (co-)integrated devices and systems in a quality controlled way.

Scope:

Proposals should build on the 2D experimental Pilot Line[36] of the Graphene Flagship and should establish a 2DM pilot line(s), where European companies, research centres and academic institutions, can produce on a pilot scale novel electronic and/or photonic devices and systems integrating 2DM.

[36] A first experimental pilot line for 2d materials was established in 2020 under the Graphene Flagship initiative: https://graphene-flagship.eu/news/Pages/Europe-developing-its-first-experimental-pilot-line-for-2D-materials-.aspx

Proposals should focus on the (co-)integration of 2DM with established technologies such as CMOS integration and heterogeneous integration.

Proposal should include supply of standard semiconductor technologies such as CMOS, Asics, planarized waveguides already adapted/optimized for 2DM co-integration.

Proposals should specify targeted added value(s) against current technologies of the integrated devices and systems as well as the starting and ending TRLs for the targeted applications

Multidisciplinary research and innovation activities should address all of the following:

- Building the toolkit and design modules necessary for creating prototype devices and systems, characterise and assess their performance and their ability to cover the device requirements of the targeted applications;
- Process characterisation and monitoring to control and guarantee quality of relevant device parameters and to allow yield predictions of the integrated devices.
- Adaptation of standard semiconductor technologies including passivation schemes, strategies to align devices over different technologies, modules to contact the 2D devices with the periphery, optimized planarization strategies and packaging services.
- Reliability and packaging requirements;
- Implementing multiple wafer runs or other offering to best cover business opportunities;
- Defining a sustainable model of functioning beyond the project lifetime and include activities preparing for the later transfer of the pilot line to an industrial production environment; examples of such activities include addressing relevant cost issues and market perspectives, potential business partners, etc.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

Proposals should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-32: Sustainable safe-by-design 2D materials technology (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Development of 2DM sustainable 'safe-by-design' technology.
- Societal acceptance of 2DM and 2DM-based technologies.
- A set of robust and verified assays for toxicity and eco-toxicity testing of 2D materials (2DM), to support regulatory requirements for their registration and authorisation for use (OECD test guidelines, REACH compliance, authorisation pathways)

Scope:

The increasing commercial exploitation of 2DM necessitates a comprehensive evaluation of their potential impact on human health and the environment. It is thus of utmost importance for 2DM technology development to understand the properties that underlie the potential toxicity of these materials. Since not all 2DMs are alike, it is essential to disentangle the structure-activity relationships for this class of materials.

Proposals should aim to ensure a safe development of 2DM technology and in the long term, a sustainable market entry/penetration of 2DM-based products.

Multidisciplinary research and innovation activities should address all of the following:

- Critical examination of 2DM health and environment issues, ranging from general toxicology, to occupational health and environmental impact.
- Studies and tests of biocompatibility and safety of 2DMs and composites along their lifecycle;
- Development of solutions to modulate potential risks by developing appropriate chemical/physical approaches towards safer manufactured materials and nanomaterials (safe-by-design 2DMs).
- Assessing the safety of 2DMs and composites at different TRL levels to develop and test best practices along the product development process, from prototypes to products tested in relevant environments in order to guarantee the highest impact possible.

Proposals submitted under this topic should include an exploitation strategy, as outlined in the introduction to this Destination.

Research should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

Proposals should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-33: 2D materials of tomorrow (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- A broad portfolio of innovative 2D materials (2DM), networks and multicomponent hetero-structures exhibiting new properties or complementary functionalities that will lead to breakthroughs in digital systems and devices.

Scope:

Proposals should create the basis for the exploitation of most promising 2DM and developed 2DM technologies.
Proposals should develop high-quality 2DM and hetero-structures platforms by exploiting most promising emerging 2DM and/or discovering new ones, and combining them in functional systems and hetero-structures. This should be achieved by pushing the boundaries of growth, characterisation methods, deposition and layer-by-layer assembly of atomically thin crystals supported by multiscale theoretical modelling of materials and devices.

Multidisciplinary research and innovation activities should address all of the following:

- Identification and demonstration of new properties and physical phenomena such as those based on the twist degree of freedom, and processes enabling new functionalities, and their implementation in proof-of-principle digital devices;

- development of new characterisation methods and of controlled, ultra clean and large scale synthesis, fabrication methods and design of 2D materials and hetero-structures based on novel approaches e.g. Artificial Intelligence assisting material assembly and material simulation, robotics-based assembly, and advanced synthetic, preparation and growth methods combined with the help of modelling and simulation.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

Proposals should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023[2024]-DIGITAL-EMERGING-01-34: Synergy with national and regional initiatives in Europe (CSA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Well-coordinated European, national and regional initiatives in the field of graphene and 2D materials (2DM);
- Further development of a strong European innovation ecosystem in 2DM-based technologies.

Scope:

Proposals should support the coordination between relevant national and regional public authorities funding research and innovation in 2DM-based technologies. This coordination should allow them to work synergistically with the goal to strengthen and complement the EU funded activities in the domain.

Coordination and support activities should address all of the following:

- Active networking of relevant initiatives and R&I communities;
- Active follow-up of the projects funded under FLAG-ERA;
- Maintaining an inventory of funding and scientific landscapes in the domain of 2D materials in Europe, for both basic and applied research.
- analysing gaps and overlaps and contributing to topics that could be included in national/regional research agendas in the field;
- supporting the national and regional actors to organise joint calls for proposals between their respective programmes and initiatives for supporting in Europe the further development of a strong innovation ecosystem in Graphene;

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

In this topic, the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

4.5 Flagship on Quantum Technologies: a Paradigm Shift

The new Digital Decade strategy includes an ambitious target in quantum technologies: “By 2025, Europe will have its first computer with quantum acceleration paving the way for Europe to be at the cutting edge of quantum capabilities by 2030”. Reaching that goal will strengthen European open strategic autonomy and limit Europe’s dependency on external suppliers of quantum devices. It will stimulate a quantum ecosystem supported by industry developments and technology transfers from research labs to fabrication, boosting market uptake and facilitating the early development of industry standards.

In quantum computing, a number of different qubit platforms are showing the potential to become the transformative machines of the future, and Europe needs to explore the widest range of promising technologies possible. The WP for 2023-24 will enable the Quantum Technologies Flagship to advance the research into different qubit platforms that it has already pursued and to extend its support to further high-potential platform technologies. This will be complemented by the development of a European quantum software ecosystem, intensifying efforts to programme quantum computing platforms and devise more practical applications with larger user communities.

The WP will also see the Flagship expanding its focus on quantum sensing and metrology, a relatively advanced field of quantum where potential commercial applications are already on the horizon. There will be enhanced support for actions aiming to enlarge the type of sensing devices or parameters that can be measured by quantum sensors, but also to bring more developed quantum sensing devices close to a mature level where they can be taken up for industrial manufacturing.

Finally, the WP will continue to support basic quantum research to explore alternative implementations and approaches to quantum technologies and to unlock the potential of next generation technologies (including basic theories and components), as well as to address the deficiencies that more mature approaches have not yet resolved.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-41: Investing in alternative quantum computation and simulation platform technologies (RIA)

Restrictions of Article 22.5 will apply.

Expected Outcome: Proposals are expected to further mature alternative and promising quantum computation and simulation platforms which have the prospects of high scalability, to complement the ones already supported by the Quantum Technologies Flagship.

Scope: In order to reach large-scale quantum computation and simulation in Europe, breakthroughs in scalability of quantum processors and simulators, devices and integrated platforms are needed, together with the ability to perform all necessary operations of the quantum systems to have a fully programmable quantum computer or simulator.

The development of alternative quantum computer and simulator systems and platforms, based for example on photonic or NV-centre platforms, should be integrating the key building blocks such as individual quantum systems (i.e. >10 qubits for a quantum computer and >50

quantum units for a quantum simulator), control electronics, software stack, applications, etc. Work should address the scalability towards large systems (>100 qubits for a quantum computer and >1000 quantum units for a quantum simulator), the verification and validation of the quantum computation or simulation, solving a concrete problem to demonstrate the quantum advantage. In addition, quantum computation platform should explore fault-tolerance.

Proposals should also cover:

1. the cooperation with the complementary projects launched specifically in the area of the enabling quantum software stack (see HORIZON-CL4-2022- DIGITAL-EMERGING-01-10: Strengthening the quantum software ecosystem for quantum computing platforms), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements;

2. any additional support they may receive from relevant national, or regional programmes and initiatives; and

3. contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across Europe, for example, through the involvement of Widening Countries.

In this topic, the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-XX Stimulating transnational research and development of next generation quantum technologies, including basic theories and components (Cascading grant with FSTP)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Support to transnational projects in quantum technologies, fostering synergy between European, national and regional initiatives and promoting broader partnerships between the European stakeholders in quantum technologies.

Scope: Proposals should support the networking and coordination of national activities in support of the Quantum Flagship by implementing calls for proposals resulting primarily in grants to third parties in this area, in accordance with the provisions of the General Annexes. Of importance is how the proposals address the gaps in the Strategic Research Agenda, not covered by the Flagship activities. Proposers are encouraged to implement other joint activities related to the coordination of public research and innovation programmes in quantum technologies, such as transnational networking, training, and technology transfer.

Proposals are expected to use financial support to third parties (FSTP) to achieve closer coordination and greater mobilisation and pooling of resources between regional, national and EU research programmes for realising the research goals of the Flagship in the area of quantum technologies. At least of 85% of the EU budget is expected to be dedicated to FSTP and the maximum amount of FSTP is EUR x million per third party for the entire duration of the action. Consortia are expected to implement co-funded joint call for proposals that leads to the funding of transnational research and/or innovation projects, for which the Commission estimates that an amount of EUR x million per project would allow the expected outcomes to be addressed appropriately. The co-funding balance between regional, national and EU contribution should target an EU funding rate of 33%.

Proposals should make provisions to actively participate in the common activities of the Quantum Flagship and in particular contribute to the activities of the exiting Quantum Coordination and Support Action.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-XX: Framework Partnership Agreement for developing large-scale quantum Computing platform technologies (FPA)

Restrictions of Article 22.5 will apply.

Expected Outcome: The Framework Partnership Agreement (FPA) in quantum computing is expected to establish a stable and structured partnership between the Commission and the institutions and organisations in quantum computing who commit themselves to establishing, maintaining and implementing a strategic research roadmap aligned with and contributing to

the Quantum Flagship Strategic Research Agenda in a scalable open quantum computing platform based on a specific quantum platform technology.

This partnership will be set up through a FPA, which will enable the completion of the research roadmap within the context of the agreement.

The consortia responding to the call may include research institutes, universities, RTOs, foundations, industry, SMEs as well as other organisations that can play a role in the realisation of these quantum computing platforms. The FPA will specify the objectives, the nature of the actions planned, and the procedure for awarding specific grants. The FPA is expected to contribute to the following outcomes:

- Demonstrate a universally programmable processor of at least 100 physical qubits (by 2027) operating in the NISQ[37] domain including firmware and having sufficient coherence to perform computations involving all of its qubits; characterised with a hardware-agnostic test suite, including real-world applications, including for hybrid quantum/HPC computing, and the capability of out-performing classical computers on a number of relevant real-world use-cases; control needs to involve a low-level control system, a compiler and a scheduler.

- By 2029, build a full stack, highly connected, high fidelity quantum computer of at least one thousand physical qubits, exhibiting scalability and capable of out-performing classical computers on relevant real-world use-cases.

- Formulate standards and interface specifications for a complete software and hardware stack.

Scope: Fostering a vibrant European quantum computing industry will require hardware, software, and the development of user interfaces. Proposals for this FPA are expected to build on the quantum computing platforms supported under the Quantum Flagship ramp up phase. Proposals should target the development of open quantum computing platforms compatible with the fabrication techniques of the semiconductor industry (e.g. silicon spin qubits), integrating the key building blocks such as quantum processors in the NISQ regime (>100 semiconductor qubits) with control electronics, low-level software, verification and validation of the quantum computation, etc.

Proposals should include practical strategies towards the break-even point of fault tolerance to increase algorithmic depth (number of operations) for quantum computing on existing platforms.

Proposals for the FPA must describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific and engineering leadership.

[37] Noisy intermediate scale quantum

Proposals for the FPA should also address how to integrate in this platform a full software stack, including a compiler and scheduler, programming tools, a suite of algorithms, etc., that would allow them to showcase their capability of solving real and concrete computational problem(s) that demonstrate a quantum advantage.

Proposals should aim at the development of open quantum computer experimental systems, and work on the reduction of their form factor.

Proposals for FPAs should also cover: (i) the cooperation with complementary projects previously launched, specifically in the area of the enabling quantum software stack (see HORIZON-CL4-2021-DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements; (ii) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (iii) any additional support they may receive in their activities from relevant national, or regional programmes and initiatives; and (iv) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across Europe; for example, through the involvement of Widening Countries.

The partnership will have a duration of 4 years.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-SGA: Developing large-scale quantum Computing platform technologies (SGA)

Restrictions of Article 22.5 will apply.

Expected Outcome: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-2023-DIGITAL-EMERGING-01-FPA: Framework Partnership Agreement for developing large-scale quantum computers (FPA), the selected consortia will be invited to submit a proposal that will implement the first 3.5 years of the action plan defined in the above FPA.

The proposal must progress the quantum computing platform in accordance with the research roadmap as defined in the FPA. This covers in particular progress in key areas such as the number of qubits to reach and the scalability potential, the fidelity / physical error rate, the further development of the underlying quantum computing processors and the low-level control of the programmability capability, the standardisation aspects, etc.

The proposal should describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific leadership. The proposal should detail activities in areas such as education, dissemination,

ethics and societal aspects. It should also describe how it will grasp the technological potential in a way that accelerates innovation in all relevant application areas. Partners will be required to give other partners access to results needed for the purpose of any other specific actions under the FPA.

The proposal should also cover: (i) the cooperation with complementary projects launched specifically in the area of the enabling quantum software stack (see HORIZON-CL4-2021-DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements; (ii) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (iii) any additional support they may receive from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-FPA: Framework Partnership Agreement for developing large-scale quantum computers (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this action the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-XX: Next generation quantum sensing and metrology technologies (RIA)

Expected Outcome: Projects are expected to contribute to demonstrate the feasibility of next generation quantum sensing and metrology technologies and devices by showing disruptive progress in the performance, reliability and efficiency of such technologies and devices and by enhancing the TRL of all (essential) components necessary to build them.

Scope:

Proposals should focus on next generation quantum sensors and metrology devices that provide extreme precision and accuracy measurements in many fields, beyond the performance of consumer devices and services, from medical diagnostics and imaging, quantum enhanced spectroscopy and imaging, entangled clocks, inertial sensors and quantum opto-mechanical sensing devices, high-precision navigation, and monitoring, to future applications in the Internet of Things.

Proposals should address: (i) the development of new methods and techniques to achieve full control over all relevant quantum degrees of freedom and to protect them from environmental noise; and/or (ii) identify correlated quantum states that outperform uncorrelated systems in a noisy environment and methods to prepare them reliably. Proposed work should exploit quantum properties (such as coherence, superposition and entanglement) emerging in quantum systems to improve the performance of the targeted sensors technologies (e.g. in terms of resolution, sensitivity or noise), well beyond the classical limits.

Proposals should target the development of laboratory prototypes (from TRL 2-3 to 4-5) demonstrating the practical usefulness of engineered quantum states of light/matter to improve sensing or imaging and develop and demonstrate optimized quantum software for detection applications in real-world applications. They should leverage interdisciplinary expertise and join forces with metrology institutes or other relevant technical fields to further advance the limits of sensors sensitivity and resolution and to implement the best control protocols, statistical techniques (e.g. Bayesian, among others) and machine learning algorithms.

Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-XX: Quantum sensing and metrology for market uptake (IA)

Restrictions of Article 22.5 will apply.

Expected Outcome: Projects are expected to contribute to mature quantum sensing technologies and devices (TRL 6-7) in different application sectors, with the goal of establishing a reliable, efficient supply chain including first standardisation and calibration efforts for rapid market uptake.

Scope:

Proposals should address the development of mature quantum sensing technologies and single or network-operating devices that have the potential to find a broad range of new applications in transportation, precise localisation, health, security, telecommunications, energy, electronics industry, construction, mining, prospection, etc...

Proposals should demonstrate advanced prototypes of such sensing technologies that provide an unprecedented level of precision and stability, making new types of sensing, imaging and analysis possible. For rapid market uptake, they should target miniaturised, integrated,

transportable quantum sensors and provide first plans for their further industrialisation through enhanced cost efficiency and user operability at higher TRL.

In order to achieve the above, proposals should include relevant actors from the whole value chain (from materials to devices and to system integration aspects). They may also include, wherever relevant, activities and actors from metrology institutes that would provide measurement methods and/or standards, including for the development of quality assurance methods and for standardisation of the targeted quantum sensing technologies.

Finally, proposals should also cover: (any additional support they may receive from relevant national or regional programmes and initiatives. They should also contribute to spreading excellence across Europe, for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-DIGITAL-EMERGING-01-XX: Quantum communication components for space applications (RIA)

Restrictions of Article 22.5 will apply.

The aim of the action is to prepare for the implementation of the space segment, and the provision of the EuroQCI's first space-based services. Actions should be focused on supporting the pre-validation of the first generation of the EuroQCI space segment interconnected with the EuroQCI terrestrial segment, as a step towards the full deployment phase where the EuroQCI space segment will be fully integrated into the EU space-based secure connectivity initiative.

The final system architecture should encompass the development and deployment of advanced optical communication to interconnect the satellites (e.g EDRS/ HydRON) and a central mission operating centre for system in-orbit validation and testing.

The final validation of the system should include the end-to-end testing and validation of the Space segment of EuroQCI and its interconnection with the terrestrial segment of the EuroQCI system.

The financing could be integrated into any investment intended to fund the EU space-based secure connectivity initiative currently under consideration.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-46: Enabling Quantum Photonic Integrated Circuit technology for quantum technologies (RIA)

Restrictions of Article 22.5 will apply.

Photonic Integrated Circuits (PIC) technologies on one side and quantum science on the other are the building blocks for development of Quantum PIC (QPIC) devices for quantum information processing, computation/simulation, communication, sensing or metrology. Photon-based approaches can address the huge challenge of implementing quantum processes in compact everyday-life devices and products.

QPIC technology has great potentials to target several application fields, in particular, but not limited to, health care, communications, environment and security, and thus has high strategic significance and major implications for the European economy.

However, to implement QPICs, research challenges have to be faced throughout the value chain, going from materials, circuit design, and technological platforms, to the realization of reliable and robust demonstrators and prototypes, and their integration and packaging. Furthermore, quantum systems are typically large, complex and costly, hindering their scalability, and thus cannot be directly used in products.

QPIC technology can address these issues, paving the way for compact, high performance, cost-effective components, that will enable quantum technology to be introduced in the market.

Expected Outcome:

- To improve over existing PIC technologies in terms of performance, functionality, integration, and packaging in a manner that facilitates scalable manufacturing.
- To demonstrate the technology capability in key enabling Quantum PIC technologies with high potential impact on the quantum technology Industry, including applications in quantum sensing, communications, computation and simulation,
- Preparing QPIC technologies for future Pilot Lines and Photonics hubs and open testing and experimentation facilities,
- Exploit the potential of QPICs for a digital, green and healthy future in Europe by providing critical components and systems for next generation applications, products and processes.
- Secure Technological Sovereignty for Europe by maintaining leadership in QPICs
- Contribution to the objectives of Digital Transformation, Green Deal, Competitiveness and Economic Growth.

Scope:

Proposals will address technology (up to TRL 4-5) in key enabling PIC technology applied to market needs. Objectives include:

- Enhancement of PIC performance, e.g. ultra-low loss; ultra-low laser linewidth; ultra-high extinction ratio modulators and switches
- Incorporation of specific quantum functionality into PIC platforms, e.g. single photon and entangled photon pair generation, single photon and photon number detection
- Multi-technology integration, e.g. incorporation of ion/atomic traps, superconducting detectors, nonlinear elements, integration of photonic readout into quantum computing and sensing devices employing other technologies (e.g. electronic, spintronic)
- Development of PICs capable of operating at cryogenic temperatures, with low power dissipation and performance optimized in the context of the operating environment
- Assembly and packaging of PICs, taking the specific challenges of quantum systems (environment, temperature, stability) into account and including integration of complementary and ancillary technologies (e.g. microelectronics) where required
- Miniaturization of previously non-scalable quantum photonic systems by implementing them in PIC form.

Proposals should identify applications in quantum sensing, communication, computation and simulation. Proposals should test and evaluate the developed Quantum PIC technologies in the context of such specific applications though trials at systems level in a representative laboratory or an operational environment.

These technologies should be developed in a manner to facilitate scalable manufacturing.

Collaboration with the Quantum Flagship initiative and the photonics partnership is crucial to be able to merge knowledge and experience in photonic technologies and quantum science.

In this topic, the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

4.6 European Leadership in Emerging and Enabling Tech.

Note: These topics are pending final decisions on the Chips act and notably whether they could be covered through the enhanced activities of KDT joint undertaking.

HORIZON-CL4-2023[2024]-EMERGING-01-xx: Chip-scale optical frequency combs for data communication, biosensors and mobile atomic clocks (RIA)

Expected Outcomes: Projects are expected to contribute to the following outcomes:

- Develop technologies for frequency combs for applications which requires multiple frequencies of coherent laser light.

- Mature the state of chip-scale platforms to establish frequency combs widely, across all spectral regions with integrated photonic technologies
- Develop concepts for new industrial applications exploiting the precision of optical frequency combs such as
    - Integrated multi-channel light sources for optical communication in data-centers
    - Highly efficient sensors that measure mid-infrared molecular spectra
    - optical atomic clocks on a chip

Scope:

Photonic integrated frequency combs (microcombs) are a novel class of on-chip frequency combs, generated by nonlinear parametric gain. In contrast to laser frequency combs, they are compact, offer large mode spacing that matches the telecommunication grid, and can be integrated with other functionality and importantly, are compatible with wafer scale integration - i.e. semiconductor volume fabrication.

Over the past decade such microcombs have made remarkable advances: they can now be operated battery powered, and integrated with III-V gain media, and have been shown in numerous novel system level applications, ranging from terabit per second coherent communication, parallel LIDAR, to neuromorphic computing, to microwave generation or astro-physical spectrometer calibration.

The proposal should address:

- The development of novel nonlinear platforms for chip-scale frequency combs
    - with higher conversion efficiencies
    - with extensions to new wavelength ranges
    - with integration options for other functional elements
    - compatible with wafer scale manufacturing
- Improve the understanding of the light states in driven nonlinear systems

Use of new nonlinear materials such as Gallium Phosphide, Lithium Niobate and others may be considered as well.

HORIZON-CL4-2023[2024]-DIGITAL-EMERGING-01-xx: low TRL research in micro-electronics and integration technologies for industrial solutions (RIA)

Expected Outcomes: Projects are expected to contribute to the following outcomes:

- Innovative semiconductor and micro-nanoelectronic systems design concepts supporting very low energy consumption, integrated security, connectivity and embedded functions.

- Alternative[38] semiconductor manufacturing process technologies able to sustain in the mid- and long-terms the fast pace evolution of device performance, miniaturisation and cost.

- Very advanced packaging solutions aiming at extreme miniaturisation and integration. (e.g., with RF communication, power

- control, passive components, sensors, actuators…)

Scope:

Proposals should:

- Address low-TRL research with high potential not yet demonstrated in the design, fabrication process and/or packaging segments of the micro-nano-electronics and integration technologies value chain.
- Innovation focus can be on materials, physic concepts, device architecture or integration technologies.
- Provide a projection of the expected gains and main figures of merit of the proposed approaches.

Multi-disciplinary research activities should be address along part of the value chain from materials, processes, equipment, metrology, back-end processing to packaging, integration and tests.
International cooperation is encouraged, especially with leading semiconductor countries (e.g. Japan, South Korea, Taiwan) in support of EU policies (and outcome of the CSA on Int' cooperation in SC).

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

[38] Alternative to mainstream Silicon CMOS technologies.

5. Destination Open strategic autonomy in developing, deploying and using global space-based infrastructures, services, applications and data

Open strategic autonomy in conceiving, developing, deploying and using global space-based infrastructures, services, applications and data, including by reinforcing the EU's independent capacity to access space, securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector competitiveness.

In this Work Programme, several Topics are particularly targeting the innovation communities, start-ups and SMEs. This is the case of the Cassini section of course but also the following topics:

HORIZON-CL4-2023-SPACE-01-13: Future Space Ecosystem and Enabling Technologies (RIA)

HORIZON-EUSPA-2023-SPACE-5X Copernicus based applications for businesses and policy making

Attention has been paid to formulate Topics enabling compact projects, with a lot of openness in the formulation in the scope, where small and agile consortium will be able to demonstrate their capabilities.

In addition, exploratory work is ongoing to maximise opportunities with the EIC (see section 5.8 Cross-cutting)

5.1 Competitiveness

HORIZON-CL4-2023-SPACE-01-11: End-to-end satellite communication systems and associated services (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR XX million.
Type of Action	Innovation Actions

Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: The expected outcomes of this topic will enable flexible end-to-end satellite communication system (including both space and ground segment) with high productivity and growing data and service requirements. Security aspects should be considered in all targeted developments. Competitiveness will be strengthened by providing growing capacity per system, as well as flexibility and agility to face uncertainties and market evolutions and improving system availability and latency to deliver high-quality experience to end-users.

Projects are expected to contribute to one or several of the following outcomes:

- Capture 50% of global accessible Telecom satellite market by 2028;
- Showcase a secure, flexible and competitive end-to-end system demonstration by 2026/27;
- Full consideration, inclusion and utilisation of satellite communication in 5G/6G network;
- Short to mid-term disruptive development and maturation of key technologies (up to TRL6) for high performance and secure communication systems;
- Contribute to EU non-dependence for the development of telecommunication technology in space.

This will contribute to developing, deploying global space-based services applications and data and contribute to fostering the EU's space sector competitiveness, as stated in the expected impact of this destination.

Scope: The areas of R&I, which need to be addressed to tackle the above-mentioned expected outcomes are:

1) R&I on technology building blocks for LEO broadband systems, ultra and very high throughput satellites;

2) R&I on Satellite Data Management and Processing for end-to-end performance improvement and on infrastructures and networks focussing ground processing and virtual network functions.

3) R&I to identify, develop and implement AI and industry 4.0 means (e.g. virtual design, digital twins, virtual testing) relevant to Satellite Communication in order to attain *Rapid*

Development, Production and *Assembly Integration and Testing (AIT)* processes in satellite life cycle and to reduce costs.

Proposal should address only one area. To ensure a balanced portfolio covering the areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

Proposals are expected to promote cooperation between different actors (industry, SMEs and research institutions) and consider opportunities to quickly turn technological innovation into commercial space usage.

Proposals under this topic should explore synergies and be complementary to already funded actions in the context of technology development at component level.

HORIZON-CL4-2023-SPACE-01-12: End-to-end Earth observation systems associated services (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: The expected outcomes of this topic will enable flexible satellite Earth-observation end-to-end systems as a strong subject of the "new space" and a very dynamic market environment with high potential. Competitiveness will be strengthened by providing growing capacity, as well as flexibility and agility to face uncertainties and market evolutions and improving system availability and latency to deliver high-quality experience to end-users.

Projects are expected to contribute to one or several of the following outcomes:

- Maintain the worldwide leadership for Earth Observation system by 2028 addressing (1) reactive very high resolution and (2) smart persistent (up to video) Earth observation;
- Showcase a flexible and competitive end-to-end system demonstration by 2026/27;
- Short to medium term disruptive development and maturation of key technologies (up to TRL 6) for high performance Earth-observation;
- Contribute to EU non-dependence for the development of Earth-observation technologies.

This will contribute to developing, deploying global space-based services applications and data and contribute to fostering the EU's space sector competitiveness, as stated in the expected impact of this destination.

Scope: The areas of R&I, which need to be addressed to tackle the above-expected outcomes are:

1) R&I on disruptive approaches for Earth observation based on a network of small satellites with innovative capabilities, e.g. high revisit times, high spatial resolution, including for video, seizing the full innovation potential of 'New Space' innovators

2) R&I on technology building blocks for end-to-end system for Earth observation

3) R&I on Satellite Data Management and Processing for end-to-end performance improvement and on infrastructures and networks focussing ground processing and virtual network functions.

4) R&I to identify, develop and implement AI and industry 4.0 means fostering digitalisation (e.g. virtual design, digital twins, virtual testing, simulators) for Earth observation in order to enhance overall end-to-end system performance, increase efficiency and reduce development and AIT time and costs in order to attain *Rapid Development, Production* and *Assembly Integration and Testing (AIT)* processes in satellite life cycle.

Proposal should address only one area. To ensure a balanced portfolio covering the areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

Proposals are expected to promote cooperation between different actors (industry, SMEs and research institutions) and consider opportunities to quickly turn technological innovation into commercial use in space.

Proposals under this topic should explore synergies and be complementary to already funded actions in the context of technology development at component level.

HORIZON-CL4-2023-SPACE-01-13: Future Space Ecosystem and Enabling Technologies (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Enable the industrialisation and new services in space by intelligent solutions and competitive concepts, exploiting synergies with terrestrial sectors and cultivating an "AppStore" and Open-Architecture mentality towards a sustainable, highly automated, flexible and economical viable space infrastructure.

Enabling technologies such as automation, robotics, artificial intelligence (AI) and electric propulsion, especially in combination with standardisation, modularisation and digitalisation are key enablers, improving space systems and satellites' flexibility and cost-efficiency, increasing sustainability and accessibility, introducing mass-customisation and cooperative design as well as simplifying and cost-efficient operations. This is needed to access a large portfolio of promising commercial applications in space and on ground.

Therefore, this topic aims at increasing the effort for developing innovative, game-changing technologies, maturing key technology building blocks as well as proposing new applications and services for the future space ecosystem.

Each project is expected to contribute to one or several of the following outcomes:

- A future space ecosystem, fostering the industrialisation and business in space as well as supporting scientifically meaningful missions by using synergies with terrestrial sectors;

- A sustainable, highly automated, flexible and economical viable space infrastructure, building on technologies and concepts for a circular economy in space, e.g. plug-and-play spacecraft functionality introducing recycling/re-use of spacecraft modules/functionalities

- New technologies and approaches for future space systems, application and services such as on-orbit services such as maintenance, assembly, manufacturing, re-configuration, recycling, logistics, warehousing, etc.;

- Short to medium term disruptive development and maturation of key technologies (up to TRL6/7);

- Contribute to EU non-dependence for the development of Space technologies.

This will contribute to, in the medium to long term, developing, deploying global space-based services and contribute to fostering the EU's space sector competitiveness, as stated in the expected impact of this destination.

Scope: The areas of R&I, which need to be addressed to tackle the above expected outcomes are:

1) R&I on new concepts (e.g. miniaturisation, scalability) including incremental and disruptive technologies for electric propulsion systems. The activities should aim at anticipating and adapting to future market and application needs (e.g. on-orbit logistic services) of European electric propulsion products and foster the emergence of disruptive concepts and technologies.

2) Development and maturation of technologies and concepts with a clear application, pathway to applications and business sustainability in mind. Applications domains can be for example:

- Innovative approaches for operations, e.g. multi-orbit constellations, upgrade/re-configuration of existing space assets for multi-mission purposes

- Next generation of services, e.g. satellite life extension, maintenance/upgrading, assembly, recycling, logistic or warehouse services

- Game-changing technologies that contribute to a sustainable space infrastructure and development supporting space debris mitigation and competitiveness

- Serial production and manufacturing concepts of small satellites, industry 4.0 means to enhance flexibility, allowing mass-customization, and fostering use of commercial-off-the-shelf (COTS) products/components

- Software for mission control, cloud-based data rooms, improving ground-based reception equipment (both ground stations and transmit/receive antennas for mobile applications).

3) R&I on functional satellite modules (Orbital Replaceable Units to deliver new/enhanced functionality to a satellite) based on the approach developed in the call HORIZON-CL4-2021-SPACE-01-12. Following that approach, the main outcome of this R&I activity is the development, integration, testing and delivery of a flight model by the end of this project of at least two functional satellite modules to upgrade the satellite platform of the orbital

demonstration mission (HORIZON-CL4-2024-SPACE-01-11) with new functionalities. The modules will be connected to the platform by using pre-existing standard interfaces (plug-and-play concept).

Proposals should address only one area. To ensure a balanced portfolio covering the areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

Projects are expected to promote cooperation between different actors (industry, SMEs, Start-ups and research institutions) and consider opportunities to quickly turn technological innovation into commercial space usage.

Owing to the level of the expected EU contribution, it is recommended to set up a compact consortium and agile with clear and complementary roles.

Proposals under this topic should explore synergies and be complementary to already funded actions in the context of technology development at component level.

Proposals should explore relevant and promising solutions derived in Horizon 2020 activities, especially project results from the Strategic Research Clusters Space Robotics Technologies and Electric Propulsion.

HORIZON-CL4-2023-SPACE-01-15: Future Space Ecosystem: Management and Coordination Activity (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Coordination and Support Actions
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Procurement for operations and further development of European Operations Framework (EOF) including the update of the EOF Guidelines for On-Orbit

Services (OOS) and evolution of the Future Space Ecosystem (FSE) roadmap considering new space approaches, enabling technologies (e.g. electric propulsion, robotics, AI) as well as continuous market and trend analyses including target-oriented dissemination activities. Defined actions will enhance and utilise synergies with terrestrial sectors and ensure complementary and coherent with ongoing or future activities in ESA and member states.

Expected Impact:

- Coherent guidelines for On-Orbit Services (e.g. life-extension, maintenance, assembly, logistics, etc.) supporting EU actors implementing their business ensuring consideration of sustainability, safety and competitiveness.

- A coordinated position of the European parties in OOS to make better use of R&I and to strengthen future space ecosystem.

Scope: Not only dedicated technology is required to foster future business in space, but also a sustainable framework, providing enough flexibility to let businesses emerge and grow in the OOS field, and ensure the continued safe use of space and space-based assets. The lack of standards in terms of technology and processes in OOS considering not only sustainability and safety but also supporting competitiveness impacts both stakeholders on the demand and on the supply side. In order to achieve a coordinated position of the European parties, this support action will ensure the continuity of the European Operations Framework (EOF), a business framework, to collaborate with all stakeholders to generate and update guidelines & principles, for OOS in the context of commercialisation, that supports further regulation, licensing and norming activities by appropriate instance. The consolidation of the EOF will support a successful commercial exploitation.

Furthermore, in close collaboration with the European stakeholders this support action will continue the definition of key elements for the Future Space Ecosystems roadmap ensuring complementary to ESA and national agencies roadmaps. Enabling technologies as defined in the Strategic Research and Innovation Agenda (SRIA) as well as new space approaches, synergies with the other activities of Cluster 4, Industry and digitalisation will be identified, considered and exploited where suitable. The objective is to maximise the business opportunities by using concepts as modularisation, standardisation, digitalisation and new industrial processes to support the paradigm shift in space system design for the future space ecosystem to increase efficiency of future in-space services.

Target-oriented dissemination activities should be implemented to facilitate support of EU stakeholders with regards to OOS and to promote EU Space R&I activities in the future space ecosystem.

HORIZON-CL4-2024-SPACE-01-11: Future Space Ecosystem: Orbital Demonstration Mission (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: The expected outcome of this topic is to prepare a European pioneering, high-impact but low-cost orbital demonstration mission of an On-Orbit Service (e.g. assembly, maintenance, life extension, functionality upgrade and reconfiguration, recycling, etc.) in 2026-2027 period that will demonstrate and showcase European know-how, support market generation, open new business opportunities, foster international cooperation and deliver a long-lasting impact in the future space ecosystem.

Projects should in particular contribute to prepare and showcase a future space ecosystem fostering the EU's space sector competitiveness, as stated in the expected impact of this destination. Further building on modularity and standardisation to enable and implement efficient on-orbit servicing, assembly, manufacturing and recycling, and facilitate a smooth transition between the short-term market needs and future commercial possibilities while respecting the protection of the in-space ecosystem.

Scope: Preparation and implementation of mission phase D for the low-cost orbital demonstration aiming at demonstration of game-changing technology and showcase of a promising commercial on-orbit service application applying and enhancing the European Operations Framework for OOS.

The work must build on the previous mission phases B2-C and assemble, integrate and test the spacecraft as well as prepare suitable solutions for launch and operations. In Phase D, the assembled and integrated satellite platform will be equipped with at least two additional functional satellite modules (Orbital Replaceable Units to deliver new/enhanced functionality) delivered by an independent developer (HORIZON-CL4-2023-SPACE-01-13) using the available and compatible pre-existing standard interface (plug-and-play concept). The mission concept ensures the demonstration of innovative satellite capabilities of re-configuration,

maintainability and recyclability during the operations phase in orbit through an exchange of the satellite functional modules (e.g. positioning of the modules on the platform).

Work done on Space Robotics in Horizon 2020 and other relevant European programmes, should be exploited where possible. The EOF guidelines should be applied to and enhanced by the orbital demonstration mission.

5.2 Access to Space

HORIZON-CL4-2024-SPACE-0N-2N Low cost high thrust propulsion for European strategic space launchers - technologies maturation including ground system tests (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3/4 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Contribution to the overarching objective of launch cost/price reduction by 50% by 2030 (with respect to A6/VegaC cost/price 2021 economic conditions), for the benefit of EU Space programmes implementation and going towards reinforcing EU‘s independent capacity to access to space.
- Innovation acceleration of enabling technologies (maturing, prototyping, on ground tests)

- Identification of mature technologies at TRL 3-4 for cost-reduction possibilities in the current European launchers
- Matured technologies up to TRL 5-6 by 2023/24, including prototyping and on ground tests at subsystem level
- Cost reduction investigation and demonstration.

These outcomes will contribute to enhance EU strategic autonomy and sector competitiveness, in line with the Expected Impact of the destination.

Scope: Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

The propulsion systems represent a significant part of launch system costs. It is necessary to mature new or optimised low cost effective (lower number of parts, better operability), high performance (high thrust to weight ratio, high specific impulse) and green propulsion concepts, technologies and propellants for high thrust engines.

The activities should address:

- Maturation of enabling technologies, building blocks, tools and processes including maintenance/overhaul and safety, up to TRL5/6 and subsystem tests including prototyping and integrated tests at subsystems level by 2023;
- Demonstration of the above technologies by subsystems and engine on-ground demonstration tests by 2026.

The matured technologies, building blocks, tools and processes should be applicable to strategic launchers able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030 and preferably earlier for current launch solutions. The tests should be appropriate to this objective.

The proposed activities must also support EU non-dependence objective and include the assessment of costs reduction investigations and test results towards the overarching objective mentioned in the expected outcomes.

The activities will address one or several of the following areas:

- low cost propulsion,
- throttability,
- reduced number of parts with extensive application of Additive manufacturing, or new composite technologies
- maintenance/overhaul,
- associated fluidics.

The activities should include as many as technologies possible in each area to maximise the number of matured technologies to be submitted to integrated tests at subsystem level and integration of subsystem (all technologies together) for engine firing tests by 2025.

All the activities should be complementary and coherent with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019 and planned to be decided at the ESA Ministerial planned in November 2022.

Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-SPACE-0N-2N New space transportation solutions and services (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3/4 and achieve TRL 5/6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Contribute to EU Green Deal objective through the reduction of the environmental impact of space transportation and to be prepared for the upcoming REACH

regulations, especially with respect to the use of hydrazine and its derivatives, focussing on commercial market as a driver for business growth.

- Contribute to expand commercial space transportation offer and services with new space transportation solutions. The objective is to contribute to double the accessible new space transportation service market to European industry by 2030.
- Design and performance studies as well as business cases (demonstration of economical viability).
- Matured technologies up to TRL5-6 including functional and qualification test on ground.

These outcomes will contribute to enhance the sector competitiveness, in line with the Expected Impact of the destination.

Scope: There are emerging opportunities in space transportation that are not yet seized by European actors characterised by new uses of space (e.g. small satellites, larger constellations and payload recovery) new destinations (e.g. direct GEO, re-entry from LEO).

The expected proposed activities should contribute to the maturation up to TRL5-6 of enabling new technologies and subsystems (including common building blocks) in the field of green propulsion, micro launchers and associated launch facilities, kick stage, orbital propulsion and distancing, attitude and landing, re-entry solutions, smart satellite deployment systems/dispensers, for space transportation including new routes up to Lunar orbit or surface.

The maturation could go up to subsystem and system level technology demonstration and must include at least one of the following areas and linked technologies:

- Technologies for recovery of Space Transport vehicles elements:
    - Technologies to be matured in order to allow the re-entry of launcher elements through the entire atmospheric flight domain from in-orbit up to soft landing on earth: Controlled hypersonic flight, the highly dynamic landing maneuver, modeling of the aerodynamics, attitude control system, actuators and propulsion system, advanced GNC design, propellant sloshing and system transient dynamics, low cost re-entry protection system.
    - Technologies enabling recovery, high reuse and limited refurbishment need of launcher fairing: concept design, structure, pyrotechnic / distancing devices, recovery means solution, demonstrators for recovery and maintenance/overhaul.
    - Technologies maturation for micro launcher first stage. reusability concepts that have a strong potential for cost reduction.
- Space Transportation technologies in support to In-orbit servicing systems:

- Technologies allowing the in orbit reuse of a green and sustainable cryogenic elements for multiple operations and missions in-orbit: green propulsion and green Kick stage, versatile operation of cryogenic upper stages as on-orbits platforms, cryogenic propellant management for long duration missions, High multi-restart capability for in-space cryogenic engines, in-orbits cryogenics tanks, electric pumps for in-space propulsion, in-space refuelling for cryogenic systems, interface and connection to in-space solutions, innovative low cost materials for in-space applications, attitude control systems (RACS), advanced avionics, GNC.

All the activities should, to the extent possible, be complementary and coherent with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019 and planned to be decided at the ESA Ministerial planned in November 2022.

Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2025-SPACE-0N-2N M Modern, flexible and efficient European test, production and launch facilities (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3/4 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

Contribution to the overall objective of launch cost/price reduction by 50% by 2030 (with respect to A6/VegaC cost/price 2021 economic conditions), for the benefit of EU Space programmes implementation and towards reinforcing EU‘s independent capacity to access to space.

- Contribute to expand commercial space transportation offer and services with new space transportation solutions. The objective is to contribute to double the accessible new space transportation service market to European industry by 2030.
- Improve cost efficiency of existing European test, production and space launch facilities.
- Feasibility study of an industrial platform (perimeter, technologies, costs), including cost benefit assessment, of key technologies in representative conditions.
- Matured technologies up to TRL 5/6 standardised technology for improving cost efficiency, interoperability of access to space ground facilities in EU, ground assets portability to speed-up deployments.

These outcomes will contribute to enhance EU strategic autonomy and sector competitiveness, in line with the Expected Impact of the destination.

Scope: Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

Europe needs to improve the cost efficiency of the access to space ground facilities and of launch systems production and operations for the strategic launchers essential for the implementation of EU space programme. It could benefit from the industry 4.0 transformational wave, which has the potential to exploit digitalisation and advanced data management for lowering the cost of low production rate facilities and further improving quality.

In addition, EU access to space ground facilities needs to become interoperable allowing to decrease the launch service costs.

The activities address technologies maturation applicable to strategic launch systems able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030.

In continuation of the work initiated during WP21-22, the activities will address one or several of the following listed domains under a) and/or b):

a. Multi sites flexible industrial platform:

Feasibility study and maturation of key technologies in representative conditions of a flexible platform as a tool for existing and future European space launcher products, to enable a cost-efficient approach including existing Manufacturing Assembly Integration and Testing capabilities as design constraints, to increase economical robustness against variable production rates in the rocket industry and to optimise transfer from existing to new launcher productions

To explore, including from other industrial sectors, the use of a value-stream mapping (including the material- and information flow) in the field of Design to Manufacturing, Integration, Maintenance and Operation capabilities including improvements based on advanced data management and Artificial Intelligence. Maturation of technologies, including for reusable parts of the launch systems.

b. Develop standardised and cost effective innovative technologies to improve cost efficiency of existing Test and Launch facilities, their interoperability and compatibility/attractiveness for new users, including one or several of the following domains :

- modern data handling, data processing, diagnostic techniques
- eco-friendly technologies,
- automation and innovative controls,
- mobile telemetry systems, mobile payload preparation facilities,
- vacuum simulation test facilities,
- security and safety

The maturation will go up to TRL5/6 and incremental demonstrations of key technologies.

In addition solutions for improving flexibility (for new actors and concepts), configurability and interoperability of European test and launch facilities, including existing operational facilities, will be address:

For launch facilities, activities shall address different standard and means related to launch range, operations, communication, safety (this may also include safety equipment to be installed on-board: development and/or tests)… The objective is to allow to operate multiple-launchers from different launch sites in order to minimize the impact on their definition.

For test facilities, activities shall address analysis with regards to flexibility for multiple/green propulsions and adaptation of engine test capacities to reach modular and smart engine test simulator.

The maturation will go up to TRL5/6 and incremental demonstrations of key technologies.

All the activities should, to the extent possible, be complementary and coherent with the ESA on-going or future activities, in particular those decided at the last ESA Ministerial held in November 2019 and planned to be decided at the ESA Ministerial planned in November 2022.

Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

5.3 EGNSS upstream (Other Actions)

2023-Innovation activities for improved EGNSS operation and service provision

The improvement of the complex operations is essential to improve the performance of EGNSS services. Likewise, maintenance activities must be subject to a continuous improvement process to guarantee the service continuity. Actions under this area will cover the development and use of service demonstrators to consolidate the future EGNSS services, the optimization of the operation schemes using advanced dynamic strategies (e.g. machine learning, advanced on-board diagnosis, predictive maintenance) for Galileo constellation / system management for the efficient and continuous provision of the full portfolio of Services in EGNOS and in Galileo, and others.

These activities will be implemented by EUSPA under the Contribution Agreement between the Commission and EUSPA. The procurement actions under this section will affect the essential security interests of the Union, and will therefore require restricted participation that will be established in the tender specifications. In such case participation should in principle be open only to entities established in the EU Member States. Participation of entities established in Horizon Europe associated countries or in third countries will be decided on a case by case basis with the approval of the annual work plan submitted to Commission under the Financial Framework Partnership Agreement (FFPA).

Indicative budget for this action: EUR xx million from the 2023 budget

2023-2024-EGNSS evolution: Technology and infrastructure-related R&D activities

Actions under this area will address upstream R&D activities. They will cover the maturing of the existing technologies and the development of new and emerging technologies, the engineering activities for the further evolution of Galileo and EGNOS existing systems, technical studies for the assessment of exploratory system concepts and/or responding to new mission needs and a changing environment, the development and maintenance of state-of-art system tools and technical test-beds, the implementation of actions agreed at Programme level to reduce the dependence of the supply chain on non-EU markets, the definition, design, development and implementation of experimental satellite demonstrator, and others.

These activities will be implemented by ESA under the Contribution Agreement between the Commission and ESA. The procurement actions under this section will affect the essential security interests of the Union, and will therefore require restricted participation that will be established in the tender specifications. In such case, participation should in principle be open only to entities established in the EU Member States. Participation of entities established in Horizon Europe associated countries or in third countries will be decided on a case by case basis with the approval of the annual work plan submitted to Commission under the Financial Framework Partnership Agreement (FFPA).

Indicative budget for this action: EUR xx million from the 2023 budget and EUR xx million from the 2024 budget.

2024-EGNSS Evolution: Mission and Service related R&D activities

The objective is to study potential new services, as well as the enhancement of already defined services, answering to new user needs and determine whether and how the EGNSS mission of Galileo and EGNOS shall be enlarged or complemented to answer these new user needs. This includes the preparation of contributions and technical analysis supporting the EU position in multilateral and bilateral working groups and meetings.

The upstream R&D actions in this area will cover the assessment of services improvements and of new services or capacities to be introduced, justifying the need, developing the service concept including with international partners when relevant, assessing costs to the programme versus benefits to users and defining the roadmap of activities until an operational service could be provided.

The procurement actions under this section will affect the essential security interests of the Union, and will therefore require restricted participation that will be established in the tender specifications.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q3-Q4 2024

Indicative budget: EUR xx million from the 2023 budget, EUR xx million from the 2024 budget

5.4 Copernicus services evolution

HORIZON-CL4-2023-SPACE-xx: Copernicus Atmosphere Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Enhanced quality and enhanced efficiency of the current service to respond respectively to policy and/or user requirements and to technological developments
- Development of efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation and implementing Big Data & analytics modern solutions to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive through.
- Development of new algorithms and processing chains preparing for the use of new types of space observation data (being from new Sentinels, other contributing missions or ESA Earth Explorer missions) in order to allow the development of new products or the improvement of existing ones.

Scope: The R&I area is:

1. Research activities to develop new and advanced aerosols modelling and data assimilation in CAMS global and regional systems in order to keep modelling and data assimilation aspects at the international state-of-the-art and benefit fully from ground-based and satellite observations, in particular from active remote-sensing (lidars). In addition new methods to advance substantially in the modelling of secondary aerosols and their interlinks with gas phase chemistry.

With an integrated modelling approach, the integration of new observational data becomes a driver for further enhancement and improved realism of the already existing production chains, assimilation systems and coupled models. The development of advanced processing and modelling techniques, as well as the exploitation of new sources of data, will be targeted to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users. The projects should take into account the existing service and clearly define to what extent the service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new products.

The main output of the project should be tools and methodologies that can be readily transferred for improving aerosol representation in CAMS operational global and regional systems. The proposal should develop activities that will improve the quality of the aerosol variables in the CAMS global and regional analyses, forecasts and reanalyses, as well as of the CAMS solar radiation products.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-SPACE-xx: Copernicus Climate Change Service evolution – Extreme event climate change attribution

Specific conditions	
Expected EU	The Commission estimates that an EU contribution of EUR xx million

contribution per project	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcomes: Project results are expected to contribute to the following outcomes:

- development of innovative and robust methodologies for characterising the likelihood of occurrence of compound and/or sequences of and/or cascading hazardous events in the present and in future climate
- development of an appropriate framework for attributing compound, sequences and/or cascading events to climate variability and change.

Scope: The R&I areas are:

2. Research activities to develop innovative methodologies to characterise compound and cascading extreme weather events including determining the potential frequency, intensity and impacts of these events in a changing climate

Because each hazard has its own set of associated impacts, and because their mutual interaction may be highly non-linear, compound or sequences of events tend to cause more severe impacts on society than single-hazard events for the same severity. Copernicus services have focused on developing tools, systems and applications targeting single hazards, potentially leading to the underestimation of the frequency and severity of high-impact events. Gaining a better understanding, in the context of a changing climate, of the likelihood, scale, frequency and impact of compound, sequences and cascading events and their possible link to climate change is crucial for Copernicus, the European research community and society in general. This research will underpin the creation of tools to monitor these events, attribute them and whenever possible project changes in their likelihood.

Given the role climate change is expected to play in the intensification of some extreme events it will be important to develop suitable operational procedures able to provide a rapid statement on the possible connection between specific multi-hazard events and climate drivers. Addressing compound events is part of the World Climate Research Programme (WCRP) strategic plan 2019-2029. This activity is expected to contribute to the advancement

of the knowledge base in this critical field. The technology to perform rapid attribution of some individual extreme climate events is close to operationalisation. The scientific understanding of compound events and their representation in climate models, needs further development to provide usable insights to policymakers and the general public.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The research should be performed using existing Copernicus datasets for identifying natural hazard events at continental (Europe) and global scales, and existing methods, models, tools and observations available at the different Copernicus Services. Examples of high-impact weather-driven natural hazards include, but are not limited to, floods, droughts, wildfires, storm surges, heatwaves and their impacts. The proposed research and development should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

Additionally, the transfer of research results to possible operations should receive active attention during the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document. In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-SPACE-xx: Copernicus Emergency Services evolution: Innovative methods and technologies to derive advanced products and open new opportunities for an operational deployment.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.

Technology Readiness Level	Activities are expected to achieve TRL6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: Project results are expected to contribute to at least three of the following expected outcomes:

- automated characterisation of building height and building use (e.g. residential, industrial, commercial, public, poor/rich) through integration of different sensor types (e.g. optical, radar, night time lights) and/or open source non-EO data,
- integration of new sensors for active global fire detection and fire monitoring from geosynchronous and Geostationary sensors, including refined post-processing for active-fire detection confidence and false alarm removals,
- integration of high and very-high spatial resolution data and sensors for continuous multi-scale mapping and assessment of fuel structure and condition at pan-European level, including active (SAR, Lidar) and passive remote sensing data,
- improvements of the hydrological predictions for the flood and drought early warning and monitoring component through data assimilation and/or multi-objective parameter calibration and regionalization using satellite based or in-situ data
- improvements of the hydrologic process representation in the continental or global scale hydrologic model of the flood and drought early warning and monitoring component
- methods for addressing limitations of SAR based flood monitoring in Urban areas or under dense vegetation, smooth or sandy surfaces, snow and/or adverse meteorological conditions. The proposed solution needs to be applicable in an operational near-real-time context and for on-demand mode as well as continuous mapping mode.
- enhanced seamless sub-seasonal to seasonal predictions of severe-to-extreme drought events and associated multi-sectoral impacts,
- optimised integration of different data sources (e.g. reanalysis + observations from rain gauges + remote sensing) and different indexes characterising droughts. Possible use of the new datasets to improve also the floods and forest fire components is encouraged (e.g. merged precipitation datasets for hydrologic model initial conditions or improved fire danger risk calculations);

- advanced drought event tracking methods;

Scope: The R&I area is:

Innovative methods and technologies for emergency related applications to derive advanced products and open new opportunities for an operational deployment addressing the needs of the Copernicus Emergency Management Service

Different aspects should be considered for the service evolution:

- enhancement of an existing element or component through e.g.: technology improvements such as optimal automation of existing processes or adding new data streams in core services; methodological improvements such as optimised modelling tools
- new elements or components to the existing (core) service;
- new services complementing the core services and providing added functionality as required by users; e.g. in a national or regional context.

Actions aimed at service evolution should be developed in response to specific policy and user requirements while seizing the opportunities provided by the evolution in technology.

Although there is no guarantee that developments will be integrated into the operational CEMS, proposals should duly take into consideration practical aspects related to the integration of results into Copernicus services, including feasibility and cost/benefit analysis as well as timeline for technology maturity of the solutions proposed and their deployment in operational environments. Proposals should aim at reaching technology readiness level TRL6, and should include either a proof-of-concept or prototype demonstrating the feasibility of the integration in the existing core service or the added-value of new elements in new application areas.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation.

Proposals should build, where possible and relevant, on free and open-source models, tools and datasets already used or produced by CEMS and the software developed should be open licensed.

The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. The possible participation of the JRC may consist in (1) ensuring access to relevant models, tools and datasets of the operational CEMS, (2) providing a good understanding of existing operational workflows and advice regarding the operational feasibility of new developments and (3) testing of new developments/prototypes in a pre-operational setting.

On data fusion, vast amounts of EO-data are now being available for applications in the disaster domains. Identification of complementary data sets, development and testing of new and innovative ways (if applicable also in the context of social innovation) to efficiently integrate them in emergency applications will be used to generate added-value and new intelligence. Besides satellite data, additional ones include in-situ observations and measurements, meteorological data from ground weather stations and radar, data from aerial platforms, social media or crowd-sourcing, as well as information generated from other sources and other Copernicus services. Whenever appropriate, the project should take advantage from Copernicus and EGNSS synergy. Potential security threats (e.g. cybersecurity) in the data flow and sensitivity of data and service products should be duly taken into account.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-SPACE-xx: Copernicus evolution for cross-services thematic domains

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Enhanced quality and enhanced efficiency of the current services to respond respectively to well identified emerging EU policy needs and/or user requirements and to technological developments
- Exploitation of the full range of Copernicus core services with a significant improvement in the coordination and integration of data and products between them
- Development of services which will support new policy(ies) and will address observational and information gaps
- Appropriate consideration of a wide range of users' needs and of potential accessibility limitations

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

1. Development of a proof-of-concept or prototype with a Copernicus based-solution to improve the European capacity to support biodiversity conventions and natural protected areas
2. Development of a proof-of-concept or prototype with a Copernicus-based solution to improve the European capacity in support of informing climate adaptation and resilience in different sectors.

This approach should foster the exploitation of space EO capabilities to close observation gaps in combination with ground-based infrastructure and innovative processing/modelling techniques. The proposed developments should be modular and scalable and proposals should provide a proof-of-concept or a prototype that can be easily integrated into the service(s).

Proposals should include the development of tools to support end users in their decision-making activities (e.g. decision support systems, assessments, decision processes) using Copernicus data and products and meeting the need for timely and quality long-term global/regional information. Proposals should have the objective to increase the capabilities and capacity of end users to use Copernicus data and products. The involved end-users should provide feedback to the proposed tools on product efficiency, data access, new measurement needs, new applied research topics, societal benefits, and other factors if necessary. If applicable also social innovation can play a role in this context.

Depending on the selected area(s), user communities should be involved in the proposal. They are mainly public authorities from national to local scale, operators of protected areas that need to be monitored, administration in charge of planning and services in charge of law enforcement. The community ranges from the fisheries or maritime authorities to land managers, foresters and park managers, environmental agencies but also administration of cultural site or universities. It also includes many of the actors that have to comply with environmental rules from the business sector.

New digital tools should be considered and innovative solutions should be proposed for an optimal exploitation of the data, improved processing and distribution chains, e.g. cloud and HPC computing, distributed computing, Artificial Intelligence, machine learning, ensemble modelling, model coupling & nesting, software as-a-service. The concept of linking with DestinationEarth to foster the use of Copernicus and Space into it should be considered by valuing the development of new core products based on latest digital technologies and mixing at least data and products from 2 services and the ground segment.

The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer from research to operations should receive full attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. The software should be open licensed.

The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could contribute to the objectives set by the DestinE initiative.

Proposals shall address only one of the R&I areas. To ensure a balanced portfolio, grants will be awarded to proposals not only in order of ranking but at least also to those projects that are the highest ranked so as to cover all the R&I areas, provided that the proposals attain all threshold.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-SPACE-xx: Copernicus in-situ component

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions

Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to two or more of the following expected outcomes:

- Optimal use of early observations. Evaluation and assessment of past observing methods and environmental factors, and on error analysis, quality control and bias adjustment of the in situ historical record;
- Better use of Copernicus relevant observations and auxiliary data collected during R&I projects not easily recoverable and reusable for validation purposes in an operational context;
- Enhanced availability and quality of in situ data critical for the production and validation of Copernicus products and data services;
- Appropriate consideration of Copernicus Services' cross-cutting challenges and R&I priorities.

Scope: The areas of R&I to be explored to help addressed the above expected outcomes include:

1. Facilitation and demonstration of efficient and methodologically sound reuse of in situ data collected during field campaigns and experiments for validation of Copernicus data and information services.
2. Development of innovative observation strategies and concepts to improve the observational capacity in selected data sparse areas. In the marine context, the gathering and qualification of acoustic observations to characterize marine ecosystems (e.g., micronekton) is an identified priority;
3. Synergistic use of complementary types of surface observations, such as pCO2 and pH observations from research vessels, ships of opportunities and Argo to improve the estimation of air/sea fluxes of CO_2;
4. Application of machine learning technologies for the quality control of historic and real-time meteorological and hydrological in-situ observations;

This approach should foster the exploitation of exiting in situ data capacities to close observation gaps in combination with new observing infrastructure and innovative processing/modelling techniques. The proposed developments should be modular and scalable, and proposals should provide a proof-of-concept or a prototype that can be easily adapted by at least one of the Copernicus Services and / or an observing network or similar delivering critical in situ data to Copernicus. The project shall demonstrate the applicability of the outcome for at least one of the Copernicus Services.

Depending on the selected area(s), relevant data providers, observing network operators, research infrastructures, and sensor manufactures should be involved in the proposal to the extent possible.

New in situ observation techniques and sensors should be considered and innovative solutions should be proposed for data processing, quality control, and automation including the use of Artificial Intelligence and machine learning.

Additionally, the transfer from research to operations should receive full attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Developed software and collected observations should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2023-SPACE-xx: Copernicus Marine Environment Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Enhanced quality and efficiency of the current service to respond to (a) policy and/or user requirements (b) technological developments implementing the space regulation (c)

complementing the challenges targeted by the Horizon Europe Mission on "Healthy oceans, seas, coastal and inland waters" and can also contribute to the initiative United Nations Decade of Ocean Science for Sustainable Development.

- Development of efficient and reliable new products chains, calling for new paradigms in data fusion, data processing and data visualisation essential for the service to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive.

- Development of new algorithms and processing chains preparing the use of the new types of space observation data (being from new Sentinels or other contributing missions) in order to allow development of new products or the improvement of existing products.

Scope:

The coastal zones have tremendous social, economic and biological value but are exposed to a high level of pressure due to climate change and human activities. It is essential to advance Copernicus solutions to answer policy (e.g. WFD, MSFD, MSP, CFP, Flood Directive, Green Deal) needs to better manage and protect the coastal zone, to ensure the development of a sustainable blue economy (e.g. tourism, energy extraction, fisheries, offshore operations, industrial port areas, cities growth) , and to build resilience to climate change, human activities being potentially exposed and vulnerable to many hazards of natural or anthropic origins, including storm surges, flooding, acidification, and degradation of ecosystems.

The objective is to implement an advanced and seamless monitoring and forecasting of the ocean from global/regional to coastal scales representative of high-resolution and high-dynamics phenomena (physics, biogeochemistry) to better constrain the coastal applications and models developed at national to local level for several applications. As such the project should encourage a co-production between the EU Copernicus Marine Service global/regional service and Member State coastal services using digital innovation and facilities (including using Copernicus DIAS if appropriate). This requires:

- The development of improved pan-EU satellite coastal observation retrievals (e.g. sea level, ocean colour, bathymetry, shoreline position, winds, waves), notably derived from Sentinel data, and an improved access and processing of in-situ data in the coastal zone.
- The development of improved inputs of freshwater flows and associated river inputs of particulate and dissolved organic and mineral matter and the development of standardized methods to couple hydrological models (for river run-offs) with Copernicus Marine and coastal ocean models.

- The development of improved coupling techniques between Copernicus Marine modelling systems and downstream coastal modelling systems operated by Member States including an impact assessment for key coastal applications (e.g. marine hazards, offshore operations, fishery and aquaculture, pollution) and EU policies (e.g. MSFD, WFP, MSP, CFP).

- New technological tools should be considered and innovative solutions should be proposed for better data exploitation, processing and distribution, e.g. move to cloud and HPC computing, distributed computing, Artificial Intelligence and machine learning (e.g. for automatic feature recognition), ensemble modelling, model coupling & nesting, software as-a-service.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service. The proposed research and development should be modular and scalable. The transfer of research results to possible operations should receive active attention during the course of the project to strengthen the technical readiness for an operational deployment in the future (e.g. system element targeting TRL 5-6). Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

The project could contribute to the objectives set by the DestinE initiative and to the Digital Twin Ocean under development following the H2020 Green Deal call and Horizon Europe calls.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document. In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-SPACE-xx: Copernicus Anthropogenic CO_2 Emissions Monitoring & Verification Support (MVS) capacity

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: The expected outcome is the continuation of the set-up of the new Copernicus element for the monitoring of anthropogenic CO2 emissions that includes:

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes, are:

- Research activities to develop new and innovative methods to improve mass conservation estimations in transport models of atmospheric CO_2 and other relevant tracers in the CAMS/CO2MVS capacity to accurately estimate CO_2 emissions and to improve the numerical schemes used in the CO2MVS capacity systems based on accurate metrics.

The main objective is to perform R&D activities identified as priorities for the Copernicus CO2MVS capacity as identified by the European Commission's CO2 monitoring Task Force[39].

The activities should support the further development of the foreseen European operational monitoring support capacity for anthropogenic CO_2 emissions. These activities should complement or follow-up on the activities within the H2020-funded CO2 Human Emissions (CHE)[40] project and the Prototype system for a Copernicus CO_2 service (CoCO2)[41] project.

The activities, as described in the Guidance document, should address a series of scientific and critical system design issues, which were defined following outcomes of the CHE project and based on recommendations from the CO_2 monitoring Task Force.

More generally, this action should support the development of an integrated support capacity, enabling European experts to collectively share their knowledge and join forces on the multiple fronts required to develop such a system with operational capabilities.

The activities should fulfil the technological and scientific requirements for the development of this European operational capacity, to further improve the prototype system to better meet user requirements and to exploit synergies with other Copernicus services.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the

39 https://www.copernicus.eu/en/news/news/new-co2-green-report-2019-published
40 https://www.che-project.eu/
41 https://www.coco2-project.eu

project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could potentially contribute to the objectives set by the DestinE initiative.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance Document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2024-SPACE-xx: Copernicus Land Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Enhanced quality and efficiency of the current service to respond respectively to policy and/or user requirements and to technological developments.
- Development of efficient and reliable new products chains, calling for new paradigms in data fusion, data processing and data visualisation essential for the service to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive.

Development of new algorithms and processing chains preparing for the use of the new types of space observation data (being from new Sentinels or other contributing missions) in order to allow development of new products or the improvement of existing products.

Scope: The area of R&I are:

1. the development of new and innovative methods to integrate the current land products into land surface and land cover change models with more sophisticated models including cross services approaches and thus extending the potential limited uptake of land product into land models, offering new dimensions and new interests for Copernicus land products. In addition the project should demonstrate the added-values of Copernicus land service products when they are integrated and/or assimilated into models.

The project should take into account the existing service and clearly define to what extent the service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new product(s).

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service. The proposed research and development should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

HORIZON-CL4-2024-SPACE-xx: Copernicus evolution for water: improving continental and global scale hydrological monitoring and forecasting

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR xx million
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Enhanced quality and efficiency of the current service to respond respectively to international policy and/or user requirements including with new scientific and technological developments.
- Development of efficient and reliable integrated products chains, calling for the set-up of a holistic approach at major watershed level for better hydrological monitoring and forecasting, combining the current Copernicus service products, and the potential development of new state of the art products complementing the existing ones. The baseline is to preserve continuity of what has been produced and achieved, but also to complement it while keeping the service modern and even more attractive.

Development of new algorithms and processing chains preparing for the use of the new types of space observation data (being from new Sentinels or other contributing missions) should also be envisaged allowing the implementation of new products or the improvement of existing products.

Scope: The area of R&I is:

> the development of an integrated, harmonized and coherent product provision system at major watershed level making use of new and innovative methods to combine the current land, inland and coastal water products with more sophisticated and/or new products, in order to improve global scale hydrological monitoring and forecasting. The development should consider cross services approaches and all relevant Copernicus service products and thus extending the potential limited uptake of inland water product into hydrological models, and offering new dimensions and new interests for Copernicus land, inland and coastal water products. In addition, the project should demonstrate the added-values of Copernicus water products when they are integrated and/or assimilated into hydrological models.

The project should take into account the existing services and clearly define to what extent the services will be improved and will provide a more integrated system with new elements or

products, including the use of enhanced models, algorithms, tools and techniques to generate new product(s).

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus services. The proposed research and development should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS).

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

HORIZON-CL4-2024-SPACE-xx: Copernicus Security Services evolution

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Enhanced quality and enhanced efficiency of the current services to respond respectively to policy and/or user requirements and to technological developments
- Significant improvement in resolution, detection capabilities, timely access to data and delivery of information according to the requirements of security applications
- Significant improvement in integration of non-space data along end-user intelligence supply chains, bringing added value at operational level (e.g. local and regional monitoring networks or field campaigns)
- Development of processing chain(s) to handle an increasing volume of satellite data, keeping underlying technology up-to-date and include new paradigms in data fusion, processing and automation to match users increasing expectations in added-value, easiness of access and visualisation.

Scope:

The Member states are calling to reinforce the Copernicus in terms of resilience and security in support to civil forces of Member States to be better prepared, better react and recover from major upcoming crisis of various forms, for example for population displacement due to climate change impacts or for extreme weather impacts on population. The Commission is as well anticipating on these needs and is considering developing an enlarged portfolio of so-called resilient services for governments, secure end-to-end, with a security of supply and complementary to national capacities.

The R&D Areas should support the improvement and extension with new features and new performances of the 3 Copernicus services with:

- New and innovative methods and technologies to exploring new and enlarged data sets for new security related applications, addressing issues not currently tackled by the 3 core services.
- Actions in support to the evolution of the security services, namely increasing user reach, responding to specific regional needs, use of extended data sets and increased added value.

The proposal should follow the specific R&D topics and guidelines provided in the *Strategic Research Agenda for Security Services* (V1.0, to be released end 2022).

The R&D areas can as well address:

- New and innovative methods and technologies to exploring new resilient services addressing the anticipation and response to major crisis that Europe needs to detect (early warning, simulations, what of scenarios assessment) and for which the Europe needs to be prepared and become resilient, addressing issues not currently tackled by

Copernicus and possibly building and going beyond the existing 6 Copernicus services.

Actions aimed at service evolution should be developed in response to specific policy and user requirements while seizing the opportunities provided by the evolution in technology.

Proposals should duly take into consideration practical aspects related to the integration of results into Copernicus services, including feasibility and cost/benefit analysis as well as timeline for technology maturity of the solutions proposed and their deployment in operational environments. Proposals should include either a proof-of-concept or prototype demonstrating the feasibility of the integration in the existing core service or the added-value of new elements in new application areas.

Additionally, the operationalisation of the research results should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-use and exploit the results (including IPR) to the entities implementing the EU Copernicus programme. The software should be open licensed in order to use, copy, study, and change it in any way.

Proposers are advised to exploit all possible synergies with other security specific actions funded under the work programme of Cluster 3 “Civil security for society”.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development should be modular and scalable.

The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants are advised to consult information on the Copernicus programme in general at https://www.copernicus.eu/en and further details on the topic in the Guidance document.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

5.5 EGNSS and Copernicus Downstream

HORIZON-EUSPA-2023-SPACE-5X: EGNNS - Transition toward a green, smart and more secure post-pandemic society (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 8-9 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Foster the development of integrated synergistic space technologies that improve the quality of life in Europe, toward environmentally-friendly and energetically-efficient communities, in support of the EU mission on climate-neutral and smart cities[42];
- Stimulate the development and use of commercial downstream solutions based on synergies between different space programme components Galileo, EGNOS and their differentiators (e.g. OSNMA, HAS, RLS, CAS etc.), Copernicus (if relevant), combined with connectivity/5G and SATCOM and cutting-edge digital technology to enable more efficient and resilient solutions for tomorrow's society;
- Exploit the increasing digitalisation paradigm and the adaptation of business processes in the post-pandemic environment to create new space-based commercial opportunities improving the prospects of businesses and the life of citizens.

Scope: The COVID-19 crisis highlighted importance of digital technologies and infrastructures as vital societal assets. EU space technologies have demonstrated to be instrumental to a large number of activities. The scope of this action is the development of space-based synergistic technologies for a green, smart and more secure solutions addressing a variety of social and economic challenges which emerged during the COVID-19 pandemic crisis.

[42] EU Mission: Climate-Neutral and Smart Cities | European Commission (europa.eu).

By leveraging EGNSS services and its differentiators, proposals should develop applications and technologies that focus on commercial exploitation in one of the following priority areas:

- Development of downstream commercial applications, which foster the creation of cities built around its citizens, developed on efficient mobility solutions, environmentally-friendly and energetically-efficient. It may also cover the development of automated solutions for personal assistance, healthcare, support to the elderly, city dashboards, or applied robotics and/or applications that boost the green, safe and digital transition of the construction industry;

- Development of downstream solutions based on Galileo, EGNOS and their differentiators, Copernicus (if relevant), combined with connectivity/5G and SATCOM and cutting-edge digital technology to enable more efficient and resilient solutions for tomorrow's society. The solutions shall address the challenge of higher reliance on the capacity provided by the existing infrastructures (Telecom, Finance, Insurance etc.), the increased use of remote resources and remote work modality and the awareness of the associated cyber-threats. It may also cover applications for claims assessment (insurance), or time-stamping of transactions (finance), as well as commodities trading and risk assessment.

Proposals could, if applicable, integrate other data sources or services, in particular, where relevant, in combination with Copernicus.

Underpinning technologies may include metaverse and/or Digital Twins (DT) for cities, industries or Critical Infrastructures, tele-presence tools, wearables, AR/VR, secure interconnected IoT networks, new cyber-security paradigms based on Quantum Key Distribution (QKD) etc.

Applications may also consider the integration of future GOVSATCOM services into their commercial solutions, if applicable.

The Proposals shall:

- Address innovative applications and technologies that focus on one or more of the priority areas defined above;

- Present a solid business plan, including the quantification of the market potential, value proposition and exploitation strategy. The elements of innovation and the challenge to overcome as well as address barriers/issues which might hinder their commercial exploitation;

- Preliminary define and be designed to satisfy user needs, possibly seeking the direct participation of users, customers and/or public authorities concerned in the proposed solution (e.g. infrastructure managers, actors in the finance and insurance domain, municipalities etc.).

HORIZON-EUSPA-2024-SPACE-5X: EGNNS - Closing the gaps in mature, regulated and long lead markets (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR x and x million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 8-9 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Broaden the reach of EGNSS, by supporting its adoption in mature, regulated long lead markets, including rail, maritime inland waterways, fisheries and aquaculture, road and automotive, aviation;
- Development of industry-accepted certification and standardization schemes that exploit the use of EGNSS and its differentiators for operational services.

Scope: Standardization and certification for the use of GNSS in regulated markets is a costly and time-consuming process. The topic aims to gaps in mature, regulated and long lead markets and deliver concrete pathways to standardization and certification towards broader EGNSS adoption. Proposals may be submitted in any of the following areas:

- Closing the related standardization and certification gaps for **rail safety critical applications** that support the rail network efficiency and cost reduction, converging towards a pan-European EGNSS-based solution adoption, within the European Rail Traffic Management System (ERTMS) evolution or adoption within railway lines that do not require a full interoperability with ERTMS. Proposals may contribute to pilot projects and tests (e.g. large-scale demonstrators within Europe´s Rail JU projects) supporting the approval of the EGNSS-based solutions by relevant safety authorities. Relevant activities to be addressed include the amendment of the ERTMS technical specifications for interoperability to support the use of EGNSS for train localization and, possible synergies with Copernicus and/or GOVSATCOM, including also the integration with other sensors for the infrastructure monitoring;

- EGNSS-supported safe operations and efficient navigation in **maritime inland waterways, fisheries and aquaculture** sectors, addressing potential standardization and certification bottlenecks and assisting a diverse pool of stakeholders, ranging from vessel operators and recreational boaters. Proposals may explore the regulatory and compliance certification conditions for the use of EGNSS and its differentiators (e.g. OSNMA, HAS, RLS, EWS etc.) to support port operations, efficient and secure navigation in inland waterways or areas previously considered too dangerous or inaccessible such as new maritime routes or shallow inland waters. Exploration of relevant synergies with Copernicus and/or GOVSATCOM could be included, addressing the certification and regulatory aspects that their use might bring;

- Addressing potential standardization and certification bottlenecks for the use of EGNSS for **road and automotive** market safety-related applications in scenarios of potential harm to humans or damage to a system/environment (e.g. connected and autonomous cars, emergency assistance), liability applications (e.g. road user charging, smart tachographs) and fleet management systems including tracking of dangerous goods. EGNSS-based systems that contribute to reducing congestion and associated emissions, improving the safety and efficiency of road transportation. Examples of areas requiring further consolidation include standardization and certification aspects for the iimplementation of the Galileo Emergency Warning System (EWS) in automotive applications leveraging the interoperability via digital maps, the Galileo HAS in the deployment of 5G high accuracy networks for automotive applications, reduction of congestion charging in urban areas, maintenance of roads and enhanced driving comfort. Exploration of relevant synergies with Copernicus and/or GOVSATCOM could be included, addressing the certification and regulatory aspects that their use might bring;

- Applications for the **aviation** market that require further consolidation include aircraft operations and planning for more efficient and green operations supported by EGNSS and its differentiators, EGNSS timing for 4D trajectory operations, EGNSS timing for System Wide Information Management (SWIM), integration of Dual Frequency Multi-constellation (DFMC) SBAS in avionics/aircraft and integration of Copernicus data into current aviation systems, on-board or on-the-ground supporting airport operations and validation of operations via DFMC and the Galileo ARAIM. Proposals may also include applications for drones urban air mobility including urban air deliveries trough EGNSS data and services for the navigation operations, supported by EO data with provision of meteorological data, terrain and obstacle information. Exploration of relevant synergies with Copernicus and/or GOVSATCOM could be included, addressing the certification and regulatory aspects that their use might bring.

The Proposals shall:

- present a solid preliminary overview of the standardization and certification gaps and propose clear steps to address and close them;

- seek the participation of standardization and certification entities or authorities concerned with the regulatory requirements of the sectors that they address.

Applications may also consider the interconnection and integration of future GOVSATCOM and/or Copernicus services into the regulatory environment, if applicable.

HORIZON-EUSPA-2023-SPACE The Galileo PRS service for governmental authorised use cases (PCP/IA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR x and x million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Pre-Commercial Procurement or Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-4 and achieve TRL 5-7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Develop the use cases for authorised civilian users based on the added value of PRS service;
- Develop the PRS applications targeting civilian users by leveraging PRS technology;
- Build on top of previous exploratory activities and lesson learnt on the development of PRS items by stimulating the corresponding downstream PRS uptake;
- Foster an EU-level cooperation of industrial entities for the development of authorised PRS applications;

Scope: Proposals should identify, design and create applications leveraging the items for the first generation of Galileo. Applications should address the governmentally authorised user communities and scenarios for which the technical, operational and security related features requirements of PRS Service constitute barriers to entry. The applications should target well-identified operational environments in which the PRS Service features (e.g. continuity of service and access control) may play a differentiator role. Representatives of potential user communities should be involved as far as possible in the development of the prototypical applications.

Multidisciplinary activities could address one of the following:

- Critical infrastructure management and security;
- Law enforcement;

Proposals submitted under this topic shall include a business case, exploitation strategy and the risk and threat analysis (highlight the risks related to the potential use of such technologies and proposed mitigations solutions on the user system level).

The submitted proposal, supported by the risk and threat analyses shall address specify of the PRS service considering the technological, policy and exploitation in the environment of use.

Development should build on existing standards or contribute to standardisation. EU- cross boarders' cooperation is requested.

Proposals submitted should ensure gathering at least 3 potential EU user communities (at least from 3 different PRS Participants).

Each of proposals will be evaluated according to SMART approach:

- **S**pecific = The activity must bring a specific added value;
- **M**easurable =
    - The activity must be beneficial/shared for the whole targeted PRS User segment;
    - The activity brings a specific output with measurable results/outcome;
- **A**ttainable/**R**ealistic = The activity must be coherent with the PRS priorities established at Programme level, coherent with the regulatory framework, and realistic in view of the operational, schedule, market and political constraints;
- **T**imely = The activity must be completed/implementable and exploitable by PRS FOC;

HORIZON-EUSPA-2023-SPACE Joint Test Activities for Galileo PRS service (Grants)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

project	selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR x million.
Type of Action	Grants
Technology Readiness Level	Activities are expected to start at TRL 3-5 and achieve TRL 6-7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. Intended 100% funding.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Support the Programme activities related to the validation of the PRS Service;
- Support the PRS Participants defined activities related to testing, validation and introduction of the PRS Service;
- Build on top of previous Joint Test Activities and lesson learnt thereof;
- Foster cooperation among EU PRS Participants;

Scope: Proposals shall be coordinated by the Competent PRS Authorities and should address actions related to the:

- validation and verification PRS Service (support to the Galileo Programme);
- testing of PRS Service and PRS items (PRS Participants actions);
- preparation of the awareness activities and uptake to the authorised users;

Proposals submitted should ensure gathering at least 3 PRS Participants (supported by the respective Competent PRS Authority that are a party to the grant).

The proposed activities shall be carried out in full compliance with applicable regulatory framework (e.g. Decision 1104/2011, PRS CMS).

The Agency intends to award the Framework partnership agreement to up to 3 consortia. The detailed tasks will be specified under the specific grants.

Each of proposals will be evaluated according to SMART approach:

- **S**pecific = The activity must bring a specific added value;
- **M**easurable =
    - The activity must be beneficial/shared for the PRS User segment;

- The activity brings a specific output with measurable results/outcome;

- **A**ttainable/**R**ealistic = The activity must be coherent with the PRS priorities established at Programme level, coherent with the regulatory framework, and realistic in view of the operational, schedule, market and political constraints;

- **T**imely = The activity must be completed/implementable and exploitable by the relevant PRS milestone to be target per each specific grant;

HORIZON-EUSPA-2023-SPACE-5X Copernicus based applications for businesses and policy making

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Innovation Actions / Research and Innovation Action / Coordination and Support Actions
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Copernicus is providing Europe with large volume of Earth Observation data As well as six Services: Atmosphere, Marine, Land, Security, Emergency and Climate Change. This opens up the possibility to develop a wide range of applications.

- Projects are expected to enhance existing applications or to develop new applications and products relying on Copernicus data and Services, making impact on users, businesses and/or answering needs from public authorities, e.g. to support policy making and implementation such as for the Green Deal or Destination Earth.

- Projects will contribute to increase the integration and uptake of Copernicus data, services and applications in the European economy, in particular the European data economy

Scope:

Applications will built on Copernicus data and the latest evolutions of the Copernicus services and may combine these with other sources of data or services, in particular, where relevant in combination with the use of new sources of data and other space capacities like data collection, satcom, navigation, in particular the European satellite positioning/navigation/timing services and technologies EGNSS.

Targeted areas should be:

1) Copernicus applications downstream of the Copernicus Emergency service for better preparedness of local authorities, citizen, local industries and services to more frequent extreme events, geohazards, prediction insurances, preparing for a better resilience to climate change, for better local emergency management and short term recovery

2) Copernicus applications downstream of the Copernicus Security service or exploiting the combination of Sentinels with national contribution missions or new space services to develop national to local services supporting resilience to upcoming major pan-European crisis like pandemics, social and economic consequences of it

3) Copernicus applications downstream of the Marine service, with special focus on biodiversity conservation, maritime spatial planning, local and demersal fisheries, coastal to shore services, new sources of pollution from land, blue carbon farming and farming as well as applications addressing the objectives of the EU mission on 'Restore our oceans and waters' lighthouses. The applications shall build on existing infrastructure (e.g. Copernicus DIAS) and services (e.g. Copernicus Marine Service) to create solutions which can be practically utilised by policy- and/or decision-makers, industry actors and/or controlling agents to support processes that reinforce sustainable use of resources, alleviating pressure on marine ecosystems

4) Copernicus applications downstream of the Land service for better land use planning, natural resources (e.g. supply chain management for the raw materials sector) and for citizen awareness and reporting of environmental and biodiversity protection issues, using the new and improved land service products such as the ground motion service products, for industrial ecosystem development, land cover/use layers and the inland water indicators

6) Applications downstream of the Climate Change Service for integrating Sentinel Data and other climate datasets in decision support systems in the area of Agriculture, Energy (e.g. planning and assessment for renewable energy resources), Hydrology, Health and Disaster Risk Reduction.

7) Applications downstream of the Atmosphere Monitoring Service that tailor, refine and combine the products for serving users particularly in the areas of air quality, health, biodiversity, wildfires monitoring and greenhouse gases.

Proposal should address only one area. To ensure a balanced portfolio covering the areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

In order to give confidence that expected outcomes will be delivered by the projects, proposals are requested to:

- Clearly identify the targeted businesses and/or needs from public authority
- Quantify the outcome of the projects on these, including on the targeted policies where relevant
- Proposals should also describe how they plan to use the existing Copernicus data and Services, Copernicus DIAS platforms and give feedback to these e.g. with recommendations yielding improved quality and integrated data management
- Where relevant, proposals should demonstrate how they build on previously developed and existing applications
- Present a clear exploitation plan describing the pathway for the use of the application(s) after the project completion as well as a business plan and/or a strategy of adoption by public authorities which includes financing perspectives, the challenge to overcome as well as address barriers/issues which might hinder their exploitation
- Demonstrate how the application answers the needs of users and associate these in the course of the projects, including for public authorities
- Rely on state-of-the-art digital technologies (e.g. AI, Big Data, HPC) which have the capacity to exploit and process the large volumes of data and make use of existing European data infrastructures (e.g. DIAS)
- Proposals could, if applicable, integrate other data sources, services and models in particular, where relevant, in combination with EGNSS services and its differentiators
- Proposal should address issues such as data quality, uncertainty and errors as well as standardisation aspects where relevant
- It is recommended to set-up a compact and agile consortium focussed on the outcome of the project

HORIZON-EUSPA-2024-XX Designing space-based downstream applications with international partners (RIA)

Specific conditions	
Expected EU contribution per project	Expected EU contribution per project The Commission estimates that an EU contribution of between xx million and xx million Euro would allow these outcomes to be addressed appropriately.

Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Technology Readiness Level Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply for proposal involving Copernicus: due to the scope of this topic, legal entities established in countries that have signed an administrative cooperation arrangements on Copernicus data access and Earth observation data exchange are exceptionally eligible for Union funding. Currently, these countries are: the United States, Australia, Ukraine, Chile, Colombia, Serbia, African Union, India and Brazil. Discussions towards similar cooperation have been started with other countries and regions (including United Nations Agencies and Asia-Pacific countries).

Expected Outcome: Projects with international partners are expected to contribute to the following outcomes:

1. The use of EGNSS and sharing of expertise with public and/or private entities to introduce EU-space based applications/solutions leveraging their innovative, unique features, in particular Galileo differentiators (authentication, high accuracy) and EU know-how.

2. The use of Copernicus data, to develop jointly algorithms, services and/or products, which serve local user needs and/or enhance the Copernicus global product quality.

3. The combined use of EGNSS and Copernicus to develop innovative downstream applications combining positing navigation and timing with Earth observation services.

Projects will also contribute to the following objectives:

- Lead to new or improved products, processes or services – using EU space technologies (Copernicus, EGNSS as enabler - that are capable of generating a marketable solution for the local market).

- Maximise and spread the benefits of space-based applications and solutions enabled by EGNSS and/or by Copernicus, to leverage downstream space excellence in particular of SMEs and universities, to facilitate investments and to foster market uptake.

- Create partnerships with non-EU entities towards commercialization, to trigger public and/or private investment from Europe and beyond to take advantage of market opportunities in Europe or local markets.

- Build capacity and awareness raising, around EGNSS and Copernicus based applications and solutions, particularly in the regulated domains.

Scope: Proposals should target one or more of the three expected outcomes. Proposal can also include the use of other space based or non-spaced based assets and services, with a preference given to those based in the EU and in the international cooperation partners countries applying to these topics.

The actions should focus on technical developments of EU-space based applications/solutions, dissemination, awareness-raising, as well as provide opportunities for the creation of business-oriented partnerships of European industry with international partners. By doing so the action should be achieving a critical mass of space based-application success stories, demonstrating the advantages and differentiators of EU space based solutions and services and making it an attractive option for public authorities, private industries and private investors in Europe and elsewhere. …

Cooperation with international partners, either public or private, is key to:

- Promoting the uptake of satellite navigation, position and timing, to enable non EU countries to benefit from the advanced and unique features offered by EGNOS and Galileo, particularly in transport and regulated domains.

- Promoting the uptake of Copernicus globally, exploiting possibilities for integrating insitu, space data and information technologies.

- Building the Copernicus full, free and open data policy, the Commission seeks to facilitate access to Copernicus data and information for interested international partners. Administrative cooperation arrangements on Copernicus data access and Earth observation data exchange have already been signed with several countries; the United States, Australia, Ukraine, Chile, Colombia, Serbia, African Union, India and Brazil. Discussions towards similar cooperation have been started with other countries and regions (including United Nations Agencies and Asia-Pacific countries). Tasks may include joint calibration and validation activities or integration of local in-situ systems to enhance the quality of data and service products.

It is important to exploit the value-added of integration of EO observation technologies (both satellite, airborne and ground based) with positioning ones, and ICT (e.g. cloud computing) from international partner countries through the development of applications, and encourage their insertion into the market. Technology promotion activities can include incentive schemes in the form of financial support to third parties, that will promote the uptake of space downstream applications across Europe and globally.

For proposals under this topic:

- Proposals dealing with EGNSS are encouraged to involve the relevant players on the European side whenever relevant (e.g. European Union Aviation Safety Agency (EASA), European Satellite Service Providers (ESSP) or Member States' Air Navigation Service Providers for EGNOS Safety of Life service to aviation, European Maritime Safety Agency (EMSA), ERA for other transports). Participation of industry, in particular SMEs, is encouraged;

- When dealing with Copernicus based applications, participation of at least one partner from a country that has signed a Copernicus Cooperation Arrangement is required; Proposals are encouraged to use the Copernicus Data and Information Access Services (DIAS), or other existing data access solutions instead of setting up their own download and processing infrastructure. They are also encouraged to integrate third-party data (including in-situ data) and envisage data assimilation into models and products made available on the Copernicus platform of the Copernicus services. Participation of partners involved in international GEO initiatives is encouraged. Participation of industry, in particular SMEs, is encouraged;

- Involvement of public authorities is encouraged, whenever relevant;

- Involvement of post-graduate scientists, engineers and researchers is encouraged, if relevant for the project.

5.6 SSA, GOVSATCOM , Quantum

HORIZON-EUSPA-2023-SPACE: GOVSATCOM user segment service demonstrator and enabling technologies (PCP)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Pre-Commercial Procurement
Technology Readiness Level	Activities are expected to start at TRL 6 and achieve TRL 7-8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome: The procurement is expected to contribute to the following outcomes:

- Support the development of the GOVSATCOM demonstration terminal enabling end-to-end validation of the first services provided by the GOVSATCOM HUB;
- Stimulate the definition of the validation strategy of the early developed GOVSATCOM services;
- Foster the definition of the GOVSATCOM tools required for the development of the GOVSATCOM terminals for the future GOVSATCOM HUB services.

The development of the GOVSATCOM demonstration terminal should leverage on the currently existing SATCOM technologies and be aligned with the services designed and provided by the GOVSATCOM HUB. The solution shall reply to the need of the validation and demonstration of the GOVSATCOM HUB functionalities with/to operational users.

Scope: The topic should support the adaptation of the existing secure SATCOM user technology for creating baseline/reference terminals and the definition of the GOVSATCOM user segment enablers including service validation and demonstration. The ultimate goal is to obtain technology allowing the Programme to perform end-to-end validation of the

GOVSATCOM HUB. In frame of the validation activities it is expected to involve stakeholders from EU Member States, in this reason the equipment should support demonstration activities of the early developed services.

Applications shall leverage the existing technology and the design decision coming from the GOVSATCOM HUB procurement. The project should support the adaptation of already existing terminals to the requirements lay down of the GOVSATCOM HUB services, however this does not preclude the new development (subject of the propose calendar and the associated risks).

As the lesson learnt from the activity, it will support the definition of:

- the Programme tools required for the development of the GOVSATCOM user terminals;
- the validation strategy of the GOVSATCOM user terminals;
- the validation strategy of the GOVSATCOM services;
- the adaptation strategy for the existing terminals towards the GOVSATCOM services.

HORIZON-CL4-2023-SPACE-61 Quantum Communication Technologies for space systems

Restrictions of Article 22.5 will apply

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR X and Y million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR Z million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected outcome:

- Support the EU space policy and foster the development of ultra-secure EU services based on or using space systems
- Ensure the EU sovereignty and non-dependence for the development of capacities leading to the availability of ultra-secure services based on QKD
- Enhance the TRL of the critical components necessary to build QKD space systems and foster the development of the associated QKD standards.

These outcomes will contribute to securing the autonomy of supply for critical technologies and equipment for QKD space systems in the EU, and foster the EU's space sector competitiveness by developing the associated ecosystem, in line with the Expected Impact of the destination. Security aspects shall be considered in all targeted developments and where necessary, information will be classified.

Proposals must address all the above-mentioned, expected outcomes.

Scope: The scope of this topic is the development of the critical components and technologies necessary to build a space quantum key distribution system. Based on the principle that any component used to generate, store, transmit, receive, decode, or use quantum information is considered a critical component, the scope of this topic covers all the critical hardware and software components necessary for the quantum key distribution function to be implemented via a satellite payload, as well as the corresponding optical ground station. Proposals will consider both Prepare and Measure (P&M) and Entangled protocols. In addition, proposals should address the issue of standardisation for QKD space systems. Proposals should propose and implement the development of international space QKD standards in existing standardisation bodies working groups (e.g. ETSI) or propose and implement the creation of new standardisation activities through the creation of additional working groups. Given the sensitivity of the developments produced within the projects, all the hardware & software developments and associated technical documents will be classified RUE.

HORIZON-CL4-2023-SPACE-62 Quantum Space Gravimetry Phase-A Study

Restrictions of Article 22.5 will apply

Expected EU contribution per project	The Commission estimates that an EU contribution of EUR xx million would allow

	these outcomes to be addressed appropriately. Two proposals will be selected. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 3 by the end of the project – see General Annex B
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected outcome:

- Support the EU space policy and the green deal by assessing the feasibility of a quantum space gravimetry pathfinder mission
- Propose a mission, system and operation concept for the Quantum Space Gravimetry pathfinder mission
- Establish the list of critical components for a Quantum Space Gravimetry mission

These outcomes will contribute to securing the EU autonomy of supply for critical technologies and equipment, and foster the EU's space sector competitiveness, in line with the Expected Impact of the destination.

Two phase-A study proposals will be selected under this call, and their outcomes will contribute to the selection of a Quantum Space Gravimetry pathfinder mission. Activities under this call will also foster the EU leadership in the field of quantum sensing technologies.

Scope: The final objective of this call is the selection of a Quantum Space Gravimetry pathfinder mission. To achieve this objective, two phase-A proposals for a feasibility study, as specified in ECSS-M-ST-10C, will be selected. The scope of this topic covers in particular the system and operations concept of the pathfinder mission leading to a technical solution deployable before the end of the decade. A particular attention will be drawn on the analysis of the critical technologies necessary to deploy this mission, and proposals shall address the technological maturation necessary to meet this objective, based on EU solutions. The proposals will detail the reviews organised under the study. These reviews, organised by the consortium, will be open to COM and ESA experts. Each study will conclude with a Preliminary Requirement Review.

It is expected to fund 2 projects

Annex: QSG Pathfinder mission statement

HORIZON-SPACE-2024-ZZZ Quantum Space Gravimetry Phase-B/C study & Technology Maturation

Restrictions of Article 22.5 will apply

Expected EU contribution per project	The Commission estimates that a EU contribution of EUR xx million would allow these outcomes to be addressed appropriately. One proposal will be selected. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14 million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. [The following exceptions apply:] e.g. [The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.]

Expected outcomes:

- Support the EU space policy and the green deal by providing the detailed definition of a quantum space gravimetry pathfinder mission

- Ensure EU sovereignty and non-dependence for the development of capacities leading to the availability of quantum space gravimetry
- Enhance the TRL of the critical components necessary to build quantum gravimetry for space

These outcomes will contribute to securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector competitiveness, in line with the Expected Impact of the destination.

One proposal for this Phase-B/C study and the associated technology maturation will be selected.

Scope: The final objective of this call is to prepare the implementation of a Quantum Space Gravimetry pathfinder mission. To achieve this objective, one proposal for a phase B/C study, as specified in ECSS-M-ST-10C, leading to a detailed definition of a quantum space gravimetry pathfinder mission, will be selected. This activity will cover both the quantum space gravimetry payload and satellite platform. This activity will also include the implementation measures that will enhance the technological readiness of the critical components leading to TRL 7 at the end of the project. This activity will be complemented by end-to-end simulation, in-situ testing of the technology (e.g. for volcanic areas, etc.) and data analysis. The proposals will detail the reviews organised under the study. These reviews, organised by the consortium, will be open to COM and ESA experts. The Phase B will conclude with a Preliminary Design Review. The Phase C will conclude with a Critical Design Review. The Phase C will only start upon successful completion of the Preliminary Design Review.

It is expected to fund one study.

Annex: QSG Pathfinder mission statement

2023 - Space Weather and Near Earth Objects

a) Space Weather

The worldwide goal of space weather activities should be to monitor and forecast SWE just like terrestrial weather. However, direct physical simulation is currently not achievable for an operational Sun to Earth system, due in part to the lack of measurements and to the complexity of the involved processes, as well as different timescales involved. Current space weather models are generally not capable of forecasting events over several days. A longer forecasting horizon would require access to data from new observation infrastructure coupled with new and improved modelling capabilities.

Research and innovation activities under this area will be delegated to ESA and will deal with “development of certain technology elements for promising precursor services” and “exploratory space weather payloads studies”. They shall be complementarity to Space

Weather services developed through the Space Situational Awareness component of the EU Space Programme.

b) Near Earth Objects

Our knowledge of the physical characteristics of the NEO population is limited. And there is a need of continuously investigate and share the physical and dynamical properties of the NEO population as a whole, either through ground-based observations or through missions to asteroids (e.g. close proximity operations to NEOs or mitigation demonstration). It is necessary to have a number of specific technologies and instruments readily available to further strengthening the science return of a mission.

Research and innovation activities under this area will be delegated to ESA and will study "precursor services / European hot-redundant Minor Planet Centre backup" and "Increase networking of MS assets".

Other Actions - Indirectly managed actions delegated to ESA

HORIZON-CL4-2024-SPACE-61-SST.MS - New & improved EUSST Missions and Services (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	One project.
Indicative budget	The total indicative budget for the topic is EUR xx million from the 2024 budget.
Type of Action	Research and Innovation Action (RIA)
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcomes:

In the coming years, an increase in the number of active objects in orbit is foreseen (e.g. deployment of mega-constellations, increased number of non-manoeuvrable small objects – SmallSats for research and scientific purposes, etc.). Additionally, the number of objects (active and inactive) to be handled by SST systems will also increase due to the use of sensors

with a higher detection capability. For example, the US Space Fence radar, declared operational in March 2020, is capable of detecting and tracking objects smaller than 10 centimetres and is expected to considerably increase the size of the space objects catalogue of the US Space Surveillance Network.

Consequently, the provision of services by the EUSST operation centres, as well as the strategy used to protect the European active satellites will have to be adapted to the arising needs. The need for the development of automated concepts becomes more relevant in order to reduce response times, reduce costs and simplify coordination activities amongst operators.

Therefore, R&I projects on "*new and improved EUSST missions and services*" are expected to contribute to the following outcomes:

- Keep the knowledge and capabilities of Europe on the Space Surveillance and Tracking domain at the leading edge.
- Adapt, improve and evolve the current EUSST initial services (Collision Avoidance; Fragmentation; Re-entry) portfolio to future user needs and space environment.
- Improve the overall performance of the EUSST services and ensure, in the long-term, a high level of performance and appropriate autonomy at Union level.
- Identify and define new missions and services (e.g. debris mitigation; debris remediation).
- Explore the implementation of new services, in complement of the three existing ones.
- Support the pre-developments and end-to-end early demonstration of new SST services.

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following: [to be developed]

1. R&I on evolution of the Collision Avoidance service towards a higher responsiveness in the case of risks (e.g. Automatic warning service), and in all phases of the spacecraft life (e.g. deorbiting, EOL, etc.),
2. R&I on evolution of the EUSST system for **debris mitigation** in order to reduce the space debris generation,
3. R&I on evolution of the EUSST System for space **debris remediation** by managing the existing space debris.
4. R&I on evolution of the EUSST Service Provision Portal in line with the evolution of the existing services (CA, RE, FG) and the inclusion of additional new ones (Debris mitigation / remediation).

As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of Articles 56 & 57 of the "Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme", and under the same Regulation the Member States are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant awarded without call for proposals according to Financial Regulation Article 195 (d) - identified beneficiary -

HORIZON-CL4-2024-SPACE-62-SST.STM.AE - SST & STM system architecture and evolutions (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	One project.
Indicative budget	The total indicative budget for the topic is EUR xx million from the 2024 budget.
Type of Action	Research and Innovation Action (RIA)
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcomes:

The environment on which the EUSST system performs its mission and delivers its services is in constant evolution (e.g. technological or political factors changing the way on which the space is used, orbital environment …).

EUSST system architecture engineering & evolutions: the analysis of the EU SST system architecture needs to continuously progress to evaluate how the system has to evolve at medium and long term, not only at network level (type, performance, number, geographical localisation... of assets) but also at data processing and at services level. Other aspects like data flow, security constraints, interconnectivity and complementarity between EU assets but also cooperation with other non-European SST systems, etc. need to be considered as well.

More generally, the reliance on space-based data and services, in particular thanks to the success of Copernicus and Galileo European programmes and the forthcoming connectivity constellation, for our society, economy, security and defence has been rapidly growing. At the same time, the emergence of new type of actors and business models (e.g. mega constellation) increases the number of satellites and debris in orbit. For this reason, space becomes more and more congested, posing a threat to the sustainability and safety of space operations and infrastructures, with a higher risk of collision and of radiofrequency interferences.

The importance of SST / Space Traffic Management (STM) is thus growing, in a context where there is lack of a clear definition at international level and no global regime and system is in place, neither are flight rules and the associated monitoring/enforcement means.

Therefore projects developed under this topic are expected to contribute to the following outcomes:

- Foster European cooperation in the SST domain and improve the EUSST performance towards larger autonomy.
- Highlight and propose solutions to fill the gaps in the current EUSST architecture.
- Pave the way on which the EUSST system has to evolve towards a higher level of performance (e.g. accuracy; number / size of catalogued objects...), quality of service (e.g. timeliness of information...) and autonomy.
- Demonstrate the complementarity, coherence and added-value of each element of EUSST system towards a more autonomous, interoperable SST system.
- Explore and look for higher levels of cooperation with other SST systems such as the US SSA system which is of paramount importance to develop long-term cooperation.
- Raise the main issues and propose relevant answers to questions posed by all those developments in various technical and operational domains based on the outcome of the previous STM coordination and support actions developed under H2020.
- Propose adaptation to the new changes, and solutions for their possible integration into the existing standards, practices and technological means.

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following: [to be developed]

As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of Articles 56 & 57 of the "Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme", and under the same Regulation the Member States are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant awarded without call for proposals according to Financial Regulation Article 195 (d) - identified beneficiary -

HORIZON-CL4-2024-SPACE-63-SST.SB - Space-based SST (mission, system and sensors network) (RIA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	One project.
Indicative budget	The total indicative budget for the topic is EUR xx million from the 2024 budget.
Type of Action	Research and Innovation Action (RIA)
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcomes:

With the increase of the orbital population and with the need of observing smaller objects to better protect the EU space assets, the need and added-value of developing Space-Based Space Surveillance (SBSS) missions in complement to ground SST networks shall be studied in Europe. Based on the experience of SBSS missions launched and operated outside Europe

(e.g. by US and Canada), Space-based SST missions and sensors network will have to be included in EUSST in order to increase the EU ability to observe and catalogue objects on various orbits, and compensate for the limitation linked to the geographical location, light and weather conditions of ground sensors.

Therefore projects developed under this topic are expected to contribute to the following outcomes:

- Study and assess several technical solutions for the development of a future European capability of SBSS.
- Explore the use of small satellite solutions to reduce CAPEX and OPEX
- To develop in the mid-term the European capacity to operate independently SBSS.
- To reduce the dependence on critical SBSS technologies and capabilities from outside Europe,

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following: [to be developed]

As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of Articles 56 & 57 of the "Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme", and under the same Regulation the Member States are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant awarded without call for proposals according to Financial Regulation Article 195 (d) - identified beneficiary -

HORIZON-CL4-2024-SPACE-01-SST.SP - SST Sensors and Processing (IA)

Restrictions of Article 22.5 will apply

Specific conditions

Expected EU contribution per project	One project.
Indicative budget	The total indicative budget for the topic is EUR xx million from the 2024 budget
Type of Action	Innovation Action (IA) with a reduced funding rate (45%)
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected outcomes: Projects are expected to contribute to the following outcomes:

Supporting the upgrade and development of on-ground assets, in particular radars and telescopes as well as data processing.

SST radiofrequency & optical sensors (radars, telescopes…) technological research & innovation: due to the increased number of objects (both active and debris) to be handled, as well as the evolution and inclusion of services in the future, R&I activities are necessary in the sensor domain, both for radiofrequency (e.g. passive ranging, radars, etc.) and optical sensors (e.g. telescopes, innovative wide field optical sensors, lasers). New promising technologies like sensors based on the use of infrared will also be considered.

- Contribution to a consolidated and efficient EUSST sensor function.
- Improve coverage area, geographical location and performance they can offer: e.g. field of view, limiting magnitude, frequency-band, accuracy, timeliness of the associated processing ...
- Ensure an optimum evolution of the configuration and use of the EUSST sensors network, including the necessary raw data processing required to provide measurement data.
- Improved integration and connectivity of value added sensors, ensuring their compliance to the minimum quality requirements (including protocols, procedures, formats and calibration status).

SST data processing research & innovation (e.g. Artificial Intelligence…): the changes and evolution in the space environment impose the need of adapting the current algorithms and data processing methods and tools, as well as to look for new one.

- Include or at least explore the possibility to use Artificial Intelligence (AI) in any SST data processing (e.g. Improvement of object detection capability; of probability of collision accuracy ...)
- Development of automatic sensor scheduling and tasking, and data processing functions

Scope: To ensure that the sensors and data processing used in the SST domain can properly address the upcoming requirements in all aspects, the following R&I activities needs to be addressed in order to tackle the above expected outcomes: [to be developed]

As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of Articles 56 & 57 of the "Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme", and under the same Regulation the Member States are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant awarded without call for proposals according to Financial Regulation Article 195 (d)

HORIZON-CL4-2024-SPACE-64-SST.SD - SST Networking, Security & Data sharing (IA)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	One project.
Indicative budget	The total indicative budget for the topic is EUR xx million from the 2024 budget
Type of Action	Innovation Action (IA)
Technology Readiness Level	Activities are expected to start at TRL T1 and achieve TRL T2 by the end of the project – see General Annex B.

Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected outcomes: Projects are expected to contribute to the following outcomes:

The topic "SST Networking, Security & Data sharing" aims to support the upgrade, development and security issues of EUSST infrastructure based on the European network of assets (sensors, operation centres, front desk …).

Although the EUSST infrastructure is supposed to stay under national control (meaning mainly sensors and operation centres), an increased coordination is needed due to the increased number of assets contributing to the European SST system. Without this interconnection and coordination, it is impossible to ensure an efficient use of the resources and an appropriate response to the challenges posed by the changing space environment.

As concrete aspects of the EUSST network (e.g. pooling of data from multiple sensor sources; exchange between multiple operations centres of Member States) shall be considered in highly detailed case studies, modelling.

SST networking of sensors & operation centres (EU SST network Command & Control): considering the increased number of objects to be handled, an increased number of events and users is expected. The European SST system has to evolve to a coordinated scheduling of the resources and assets, ensuring that the events are covered in an optimum way, while the current survey and tracking of the space objects population continues to be performed. Evolution of the European SST network includes the Front Desk in charge of the interaction with the users (users' needs, monitoring of the service performance, etc.).

- Raise the main issues and propose relevant answers to the increasing complexity and missions constraints of the EUSST network.
- Connectivity and interface consolidation of network function between sensors / database / operating centres / front desk (reliability, maintainability and agility).
- Develop EUSST network in order to include a future new SBSS segment.

Research on EUSST network hardening against external threats: the research concerns security-critical aspects of the existing EU SST network. Various external threats shall be considered in the research activity (e.g. cyber threats or other malicious activity). Research specifically applying to the hardening of the EU SST network could add value to existing research on network hardening that looks at computer networks and other related networks more generally.

- A secured and resilient EUSST infrastructure.

Next generation exchange protocols / solutions for SSA enhancing interoperability and security (robustness, information assurance, intrusion detection…)

- A secured and resilient EUSST infrastructure
- Define the need for SST-specific tools and solutions with regard to enhanced data interoperability and data security.

Scope: the following R&I activities need to be addressed in order to tackle the above expected outcomes: [to be developed]

As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of Articles 56 & 57 of the "Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme", and under the same Regulation the Member States are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant awarded without call for proposals according to Financial Regulation Article 195 (d) - identified beneficiary -

HORIZON-EUSPA-2024-SPACE: EU GOVSATCOM for a safer and more secure EU (PCP)

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Pre-Commercial Procurement
Technology Readiness Level	Activities are expected to start at TRL 6 and achieve TRL 7-9 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant	The rules are described in General Annex G.

Agreements	

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Identification, assessment and development of a suitable use case in the area of surveillance, crisis management and key infrastructure;
- Develop the application, including the GOVSATCOM operational terminal, necessary to enable end-to-end demonstration of the selected use case(s) using services provided by the EU GOVSATCOM Hub;
- Perform extensive in-field activities aimed at verifying the suitability of the solution, involving the relevant user communities to grow awareness and stimulate adoption of the EU GOVSATCOM services by the concerned users;
- Elaborate the definition of the validation strategy and gather users' feedback to feed the development and the evolution of the EU GOVSATCOM services;

The GOVSATCOM use cases and associated operational terminals could leverage, when possible, on previous development (e.g. EUSPA demonstration terminal). The operational terminal shall verify its compatibility with the EU GOVSATCOM services, with the operational constraints and needs, and thoroughly assess the performance in the field while promoting the integration of secure communications in already existing systems and use of other space components, such as EGNSS and Copernicus.

The projects shall aim at increasing awareness on the benefits brought by the use of secure services provided by EU GOVSATCOM and will engage the users, public authorities and policy makers to the maximum extent.

Scope: Proposals should select one GOVSATCOM use case and support the adaptation of existing SATCOM terminals. The operational terminal should be tailored to target one selected use case to be proposed by the beneficiary. The target use cases may be selected among (non-exhaustive list):

- Surveillance, including both land and sea scenarios;
- Crisis management, such as maritime emergency, search and rescue, telemedicine, humanitarian aid, civil protection, law enforcement, EU external action;
- Key infrastructure, such as transport (Air, Rail, Road, Maritime) management, space infrastructure, institutional communication, critical infrastructure (energy grid, CBRN, financial infrastructure, telecommunication/ICT).

The beneficiary should build a consortium and develop an operational terminal to demonstrate the access of the respective users to an early EU GOVSATCOM service. The beneficiary should take into consideration the necessary transfer of know-how and IPR between the consortia developing the operational use case and the reference terminal as a basis. The

beneficiary should demonstrate the use of the developed operational terminal and disseminate the findings of the development and the demonstration.

In frame of the demonstration activities it is expected to involve the MSs stakeholders and the equipment should therefore support the demonstration activities of the early developed services.

5.7 Support European "New Space" entrepreneurship through CASSINI Space Entrepreneurship Initiative 2021-2027

Business development, acceleration and upscaling of start-ups will be fostered across all space areas under the CASSINI Space Entrepreneurship Initiative. CASSINI will provide support to business and innovation-friendly ecosystems, including the strengthening business skills in the space market segments and digital services based on space data. The objective is to make start-ups and scale-ups investment-ready and able to secure venture capital funding. Synergies with the InvestEU programme and the Space programme will be established.

Action 1: CASSINI Business Accelerator

Implementation: the action will be implemented by the Commission and EUSPA through a call for tender in 2022 to select a consortium of European business accelerators and sign a service contract for a 2+2 year duration. EUSPA will activate the extension (Year 3+4) of this existing contract with the 2024 Horizon Europe WP.

Amount: The extension of the existing contract for CASSINI Business Accelerator (Year 3+4) will be made by EUSPA in 2024 and the budgetary commitment of EUR 8.50 million from Horizon Europe will be made in 2024.

Expected Outcomes:

- The aims are to promote commercial use cases for the EU's space programme by providing qualified business development support. The objective is to increase the number of space-based companies that achieve high revenue growth. This will allow the companies to attract investments and capture new market shares.
- The expected economic benefits include an increase in the number of successful start-ups and scale-ups using space data and space technology, through an increase in sales, market share growth and staff hiring. These outcomes will allow the companies to attract larger amounts of financing through bank loans and equity investments.

Form of Funding: Procurement

Type of Action: Public procurement (existing contract)

Indicative budget: EUR xx million from the 2024 budget

Action 2: CASSINI Hackathons & Mentoring

Implementation: the action will be implemented by the EUSPA through a call for tender in 2024 for a 2+2 year contract.

Amount: The contract for CASSINI Hackathons & Mentoring (Year 1+2) will be a commitment of EUR 2.4 million on the 2024 Horizon Europe WP.

Expected Outcomes:

- To stimulate the spur-of-the-moment development of innovative applications based on data and information coming from Copernicus satellite images and EGNOS and Galileo positioning signals and services.
- To develop prototypes further into viable business propositions.
- To provide training opportunities on how to access and use data from Copernicus and EGNOS/Galileo with data analytics tools and artificial intelligence.
- To promote the EU's space programmes Copernicus and EGNOS/Galileo to a broader audience.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative budget: EUR xx million from the 2024 Horizon Europe WP.

CASSINI In Orbit Demonstration/Validation (IOD/IOV) service

To ensure EU non-dependence and competitiveness in technologies, there is a clear need for a regular, sustainable, cost-effective and responsive In Orbit Demonstration/Validation (IOD/IOV) service in the EU. Space flight heritage in real conditions and environment is often required to de-risk new technologies, products, concepts, architectures, services and operations techniques be that for unique or recurrent, institutional or commercial missions.

Intended results of the action is to provide a service for regular aggregation (if needed), launch and operations in orbit for IOD/IOV experiments; the objective is to have at least one opportunity every year during the Horizon Europe implementation period. This will contribute to reduce the time to market or operational use of new technologies, products, concepts, architectures, and operations techniques.

The IOD/IOV activities intend to provide a regular and cost-effective service and solution for common flight ticket actions (management, spacecraft design including reuse of existing solutions, assembly, integration and tests, launch and operations) based on EU solutions both for the spacecraft (i.e. platform, experiments aggregation, operations in orbit including preparation and associated Ground Segment) and for the launch services.

The scope of the activities may include mission design, integration and implementation, for all the necessary tasks to prepare, provide and operate spacecraft(s), together with the related ground segment, which accommodates the selected IOD/IOV experiments as well as the associated launch services.

For the aggregation and operations, the activities include:

- System studies, at ground and space level, including the compatibility with the available launchers;
- Input to the launch mission analysis performed by the launch service provider;
- Selection, assembly, integration and testing of the spacecraft(s) and related ground segment;
- Management of interfaces with and between the different IOD/IOV experiments, between the spacecraft and the launcher and between the spacecraft and the ground segment;
- Preparation of the spacecraft(s) for the flight;
- In-orbit testing and operations including data provision.

Concerning launch aspects, IOD/IOV activities should support the European launcher exploitation policy, therefore relying as far as possible on EU manufactured launcher solutions launched from the EU territory. The actions will include the provision of flight opportunities with EU manufactured launchers which encompass the mission analysis, the verification of interfaces between the spacecraft and the launcher, the preparation of launch campaign and the flight up to the injection of the spacecraft(s) on the required orbit(s).

5.8 Cross-Cutting

HORIZON-CL4-2023[and 2024]-SPACE-8N: Space technologies for European non-dependence and competitiveness

Restrictions of Article 22.5 will apply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection

	of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million in 2023 [and EUR xx million in 2024]
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	
Technology Readiness Level	Activities are expected to achieve TRLn (areas x,y,z) by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the additional exploitation obligations: For a period of up to 4 years after the end of the project, access rights to the use of products and/or processes generated by the project shall be given to European entities, in compliance with the signed Grant Agreement and with no legal restrictions and limitations stemming from International Traffic in Arms Regulations (ITAR), EAR99 or equivalent instruments applicable in other jurisdictions. Applicants must acknowledge and incorporate this obligation in the proposal and Annex I to the Grant Agreement.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- To reduce the dependence on critical technologies and capabilities from outside Europe for future space applications;
- To develop or regain in the mid-term the European capacity to operate independently in space;

- To enhance the technical capabilities and overall competitiveness of European space industry vendors on the worldwide market;
- To open new competition opportunities for European manufacturers by reducing dependency on export restricted technologies that are of strategic importance to future European space efforts;
- To improve the overall European space technology landscape and complement and/or create synergy with activities of European and national programmes either in the space or non-space fields.

Scope: Research and innovation to mature critical space technologies selected from the European Commission-ESA-EDA Joint Task Force (JTF) List of Actions shall be implemented in 2023[2024] for the following technology areas.

2023

- [JTF-2021/23-3] - High speed DAC-ADC based on European Technology
- [JTF-2021/23-5] - High data rate (12.5 to 28 Gbps or higher 56 Gbps), low consumption, short range links
- [JTF-2021/23-24] – A - Enhanced performance and space qualified detectors
- [plus Area(s) not addressed by selected proposals in calls 2021-2022]

2024

- [JTF-2021/23-19] - Low shock Non-Explosive Actuators (NEA) fOR SMALL satS
- [JTF-2021/23-23] - Power laser sources in the eye-safe region
- [Plus: 2-3 new areas coming from the new JTF cycle (timing tbc)]

Context information and high-level requirements, including description of scope, initial and target TRLs, and, where applicable, references and information of related activities, are provided in the JTF List of Actions 2021-2023. Accordingly, a technical guidance document, based on the JTF List of Actions 2021-2023, is published on the Funding & Tenders Portal outlining all relevant information to the selected actions.

Proposals should address only one area. To ensure a balanced portfolio covering the areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

Activities should be complementary and create synergies with other European activities in the same domain either in the space or non-space fields. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries, including technology research institutes and academia. An assessment of commercial viability

of the supply chain should be done. Identification of critical dependencies and, if applicable, a business plan for commercialization, including time to market indication, of the developed product and/or full range of recurring products should be included.

To achieve the non-dependence objective, applicants must

- Describe the technologies and/or technology processes to be used and show that they are free of any legal export restrictions or limitations, such as those established in the International Traffic in Arms Regulations (ITAR), Export Administration regulation (EAR) such as EAR99 or equivalent instruments applicable in other jurisdictions;
- Set up a suitable technology development process aiming at avoiding export restrictions of non-EU states and assess vulnerabilities of the supply chain.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Unless otherwise agreed with the granting authority, beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners or subcontractors are established in countries which are not eligible countries or target countries set out in the call conditions.

HORIZON-CL4-2023-SPACE-8N: Scientific space data exploitation

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR xx and xx million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR xx million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL3-4 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Support the data exploitation of European missions and instruments, in conjunction, when relevant, with international missions.
- A higher number of scientific publications based on Europe's space data, high-level data products made available through appropriate archives, and tools and methods developed for the advanced processing of data. Projects are also expected to add value to existing activities on European and international levels, and to enhance and broaden research partnerships.
- Increased collaboration of scientific teams both within and outside Europe across different domains.
- To strengthen European scientific excellence and support the development of leading edge scientific research in Europe

Scope: Exploitation of all acquired and available data provided by space missions in their operative, post-operative or data exploitation phase ensuring complementarity with activities already supported by ESA or national agencies during development phases.

Given the continuously increasing complexity and volume of these data, this requires innovative data processing technologies (e.g. machine learning, inversion techniques,...), "time series" analysis (which is already common in Earth and Climate Science), joint processing of various (space and ground) data, as well as sophisticated end-to-end simulations

Projects may rely on data available through ESA Space Science Archives when possible or other means (e.g. instrumentation teams). Combination and correlation of this data with international scientific mission data, as well as with relevant data produced by ground-based infrastructures all over the world, is encouraged to further increase the scientific return and to enable new research activities using existing data sets. These activities shall add scientific value through analysis of the data, leading to scientific publications and higher level data products, tools and methods. When possible, enhanced data products should be suitable for feeding back into the ESA archives. Resulting analyses should help preparing future European and international missions.

International cooperation is encouraged in particular with countries active in space exploration and space science.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Maximising funding opportunities with the European Innovation Council

This action will maximise funding opportunities under the European Innovation Council for space innovations developed by research teams and SMEs, including start-ups.

This Work Programme contributes to achieving the objectives of the European Innovation Council to identify and support breakthrough technologies and game changing innovations to create new markets and scale up internationally, notably in the area of space upstream and downstream with a view to deploy necessary EIC instruments from pathfinder to transition and accelerator.

Full details on the EIC calls are provided under the Horizon Europe EIC Work Programme 2023 and EIC Work Programme 2024.

6. Destination: A human-centred and ethical development of digital and industrial technologies

6.1 Leadership in AI based on Trust

HORIZON-CL4-2023-HUMAN-01-01: Meeting ethical requirements for trustworthy AI: sustainability and environmental wellbeing (AI Data and Robotics Partnership) (RIA)

As defined in the ethics guidelines on AI[43], one of the 7 key requirements of Trustworthy AI is "Societal and environmental wellbeing " dimensions of the technology - to help tackling one of the most pressing societal concerns.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Strengthening EU's strong ecosystem of AI, Data and Robotics excellence in world class foundational and application-inspired and application-oriented research;
- Scientific progress in AI addressing major challenges hampering the deployment of AI, Data and Robotics technologies;
- Ensure, in general, the pipeline of high-quality, representative and privacy-cleared training data for AI development in all relevant sectors
- Support data preparation processes that lead to greener and more trustworthy AI

[43] https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines/1.html

Scope:

There is a need for greener AI system, consuming less energy and with lower carbon footprint. Some of today's most powerful machine learning methods are compute- data and energy-intensive, raising questions about the energy consumption of AI and how best to manage these resources. The objective is to develop AI solutions which are less energy and less data consuming, while keeping sufficient level of performance (accuracy, robustness, etc)[444546474849]. Such solutions are of relevance also in the context of "embodied AI", i.e. embedding AI capabilities in robotics, especially small (down to micro/nanoscale), and long-term autonomy in all facets.

Proposals should focus on one or several of the following areas:

- end-to-end data collection/mining methods and data pipelines to provide AI systems with reliable, high-quality and privacy- and IPR-compliant training data;
- lighter, less data-intensive and energy-consuming models, optimized learning processes that require less input (data efficient AI); optimized models; data augmentation;
- Generating and using synthetic data to reduce the need for large volumes of real and potentially sensitive data
- ML methods that can deal with lower volumes and lower quality data such as transfer learning; one-shot learning; continuous and/or lifelong learning[50];
- Optimized architectures for energy-efficient hardware

The work should contribute to greener AI, increasing data and energy efficiency of AI, and rationalize the provision of data for AI. The work should build on latest results in self-configuring, low-power or energy-harvesting sensor devices, low power data transmission and energy reduction in big data analytics (e.g. a framework that optimises calculations, leading to decreasing use of energy, etc.) and should support appropriate AI paradigms (central, distributed, dynamic, hybrid), responding and adapting easily to the needs of the use situation, and to the changing characteristics, availability and use conditions for data.

Target AI systems should be appropriately evaluated and results analysed and fed back to ensure continuous improvement of the "data for AI" pipeline.

Multidisciplinary research activities should address all of the following:

[44] https://theconversation.com/it-takes-a-lot-of-energy-for-machines-to-learn-heres-why-ai-is-so-power-hungry-151825
[45] AI's Carbon Footprint Problem (stanford.edu)
[46]https://www.techtarget.com/searchenterpriseai/feature/Energy-consumption-of-AI-poses-environmental-problems
[47] 11 Ways To Reduce AI Energy Consumption (semiengineering.com)
[48] 2111.00364.pdf (arxiv.org)
[49] Frugal AI: less data and energy intensive algorithms (orange.com)
The role of Artificial Intelligence in the European Green Deal (europa.eu)
[50] https://hellofuture.orange.com/en/towards-a-less-data-and-energy-intensive-ai/

- Proposals should involve appropriate expertise in all the relevant disciplines, such as e.g. engineering, data science, computer sciences, mathematics, and where applicable in Social Sciences and Humanities (SSH).

- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms, especially the actions funded in the Digital Europe programme, under the chapter "Cloud, data and artificial intelligence".

- Contribute to making AI, data and robotics solutions meet the requirements of trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform, Digital Industrial Platform for Robotics and Common European data spaces, and if necessary other relevant digital resource platforms in order to enhance the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

The provenance, associated metadata and any other contextual information should be collected and maintained to the extent necessary in order to enable validation and support explainable AI and to ensure continuous compliance with applicable legislation (e.g. GDPR, AI act, data act).

This topic implements the co-programmed European Partnership on AI, data and robotics.

HORIZON-CL4-2023-HUMAN-01-02 Large Scale pilots on trustworthy AI data and robotics addressing key societal challenges (AI Data and Robotics Partnership) (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Strengthening EU's ecosystem of AI, Data and Robotics excellence and innovation in world class foundational and application-inspired and application-oriented research;

- Technology progress in AI addressing major challenges hampering the deployment of AI, Data and Robotics technologies;

- Increase the innovation potential, towards a wide-scale uptake of AI, Data and Robotics technologies by industry and end-users towards the targets of the Digital Compass 2030.

Scope:

AI is key to maintain European sovereignty in major industrial sectors strategic for Europe. Human-centric approaches are key to acceptance and to ensure safety, security and protection of fundamental right. To assure safety and human acceptance trust is mandatory. AI based solutions and tools can boost societal wellbeing and economic growth. To promote their deployment and uptake, there is a need to test and improve their robustness, performance and reliability in real-world scenarios and on concrete use cases to identify and overcome barriers to their deployment. Large scale pilots involving industry and end users can demonstrate how AI, Data and Robotics enabled solutions can benefit, both industry as well as a society, demonstrating robustness and "trustworthiness" (in all its dimension). Pilots should target technological advances with large scale potential impact on strategically important sectors with societal impacts such as healthcare, improved working and/or living conditions, etc.

Multidisciplinary research and innovation activities should address all of the following:

- Proposals should involve appropriate expertise in all the relevant disciplines, such as engineering, computer sciences, mathematics, Social Sciences and Humanities (SSH), biology, etc. and involve the relevant expertise to address the selected application sector.

- Build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

- Involvement of end-users in the requirement and validation of the pilots to ensure human-centric approach and maximise acceptance.

- Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

This topic implements the co-programmed European Partnership on AI, data and robotics.

HORIZON-CL4-2024-HUMAN-01-01: Foundational & novel approaches towards the next level of trustworthy, robust, reliable and autonomous AI systems, supporting the AI Act (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Enhanced robustness, performance and reliability of AI systems
- Improved accountability, transparency and autonomy of AI systems
- Strengthening EU's strong ecosystem of AI, Data and Robotics excellence in world class foundational and application-inspired and -oriented research.
- Advances in autonomy, robustness, but taking into account aspects as fairness, privacy, accountability, transparency

Scope: Trustworthy AI solutions, that are robust, safe and reliable need to be able to provide explanations, or insights into causality, account for concerns about fairness, be robust when dealing with such issues in real world conditions, while aligned with rights and obligations around the use of AI systems, data use and privacy in Europe. Advances across these areas can help create human-centric AI[51], which reflects the needs and values of European citizens and contribute to an effective governance of AI technologies.

To achieve robust and reliable AI, novel approaches are needed to develop methods and solutions that understand and anticipate system performance, to calibrate uncertainties in AI systems, and to advance AI algorithms that can perform safely and reliably in real-world conditions. The research should aim at advancing the major capabilities, such as accuracy, robustness, verifiability, reproducibility, as well as technical solutions to meet the requirements stemming from ethical, and legal requirements to achieve trustworthy AI, such as transparency, accountability, privacy, fairness. The focus is on foundational AI and machine learning research, such as

- transformers, reinforcement learning, unsupervised learning, small data learning, privacy-preserving de-biasing federated and edge-learning
- hybrid approaches integrating learning, knowledge and reasoning, model-based approaches, neuromorphic computing, automated machine learning
- Continual learning, long-term learning, both for robotic and software-based systems
- Auto-AI, automating the end-to-end learning to lower the threshold for companies and organizations to use the latest and most advanced AI/ML methods

[51] A European approach to artificial intelligence | Shaping Europe's digital future (europa.eu)

- Multi-modal learning, especially multi-modal language models (incl. natural language processing taking into account multilingual and multicultural aspects)

Multidisciplinary research activities should address all of the following:

- Proposals should involve appropriate expertise in all the relevant disciplines, such as engineering, computer sciences, cognitive sciences, neuroscience, mathematics, biology, Social Sciences and Humanities (SSH), etc.

- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

HORIZON-CL4-2024-HUMAN-01-02 Next generation AI systems incorporating collaborative intelligence – combining the best of machine and human (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- advancements in human-computer interaction

- improved human decision-making and analytic abilities

- increased automation of processes

Scope:

The R&I priorities require work at different levels, including both foundational research and large-scale piloting efforts, concentrated in large impactful projects, bringing critical mass of expertise and investment to demonstrate potential for major application sectors respectively. This would be complemented with Digital Europe actions (e.g., through Testing and Experimentation Facilities, etc.).

Research should focus on:

- foundational research towards the next generation of AI, with large efforts, bringing excellence and critical mass

- advanced simulations to explore the consequences of different interventions and/or to explore the design approaches that help manage different uncertainties as well as
- integrating advances from human-computer interaction in order to create AI systems that better and more naturally serve human needs.

Multidisciplinary research activities should address all of the following:

- Proposals should involve appropriate expertise in Social Sciences and Humanities (SSH)
- Research should build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.
- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.
- Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights including critical aspects such as robustness, safety, reliability, in line with the European Approach to AI. Ethics principles needs to be adopted from early stages of development and design.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share communicable results with the European R&D community, through the AI-on-demand platform or Digital Industrial Platform for Robotics, public community resources, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding; enhancing the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

6.2 An Internet of Trust

HORIZON-CL4-2023-HUMAN-01-11: Framework Partnership Agreement (FPA) for the Next Generation Internet commons

Expected Outcome: The partnership is expected to contribute to the following outcomes:

- A renewed internet aligned with values commonly shared in Europe such as protection of privacy, inclusiveness, transparency, autonomy, openness and cooperation across borders.

- A trustworthy internet centred around humans in control of their internet experience with improved trust, privacy, portability, discoverability, inclusion, and better sharing and search of personal and non-personal data, implementing optimal balance between decentralisation, security and energy efficiency and ensuring more socio-economic benefits.

- A structured and impactful eco-system of talented contributors driving the creation of new internet commons based on open source software, open standards and open hardware and designs.

- A new landscape of European organisations (e.g. foundations) ensuring sustainable growth and maintenance of strategic internet commons.

- A fruitful collaboration with like-minded efforts at European level and globally.

Scope: The general objective is to nurture a structured eco-system mobilising top value-driven open source innovators in Europe enabling to create, mature and grow new internet commons. These commons encompass the whole internet stack from open hardware, networking and transport technologies, firmware, operating systems and virtualisation, electronic identities and middleware, decentralised ledgers, software productivity tools, traffic supervision tools, up to over the top internet and vertical applications.

The proposers should devise a plan addressing the following specific objectives:

- To attract top open source innovators by translating the NGI narrative into motivating challenges for value driven people.

- To fund projects contributing to internet commons through financial support to third parties based on excellence, respecting the principles of fairness, transparency, confidentiality and no conflict of interest, while avoiding duplication of efforts by reusing existing commons.

- To mature solutions by e.g. performing security and accessibility audits, providing advices on licensing regime, on deployment and packaging, localising the solution.

- To grow solutions to critical mass by animating actively the community, creating synergies and momentum among like-minded projects, advising on standardisation path and by identifying funding sources.

- To transition to sustainability by providing legal hosting, supporting community management, and advising on governance and funding models.

- To elaborate a strategic and coherent picture of the funding effort identifying maturity levels and pursuing the objective of minimising the deployment effort.

- To ensure transparent governance translating policy input into priorities and striving for European autonomy for internet commons.

- To develop alliances with like-minded efforts in Europe and globally, create synergies with other NGI actions (notably NGI pilots) and promote the results to relevant audiences such as operators, users, policy makers and public at large.

Proposers should demonstrate their experience and understanding of open source communities and their expertise covering the full open source life cycle through proven track record including years of experience and indication of volume of open source projects supported.

The long-term cooperation between the Commission and the selected partners will be formalised within a Framework Partnership Agreement covering the remaining duration of Horizon Europe. The extended duration of the partnership is justified by the need to cover the full life cycle of open source projects until sustainability.

Through the Framework Partnership Agreement (FPA), the Commission intends to award specific grants to implement the FPA, in accordance with the procedures laid down in the FPA (see also section on "Other actions").

HORIZON-CL4-2023-HUMAN-01-12: Pilots for the Next Generation Internet (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Apply Next Generation Internet (NGI) technologies in a variety of industrial and societal use cases, enabling the emergence of internet ecosystems supporting the needs of key vertical sectors with high socio-economic impact.
- Generate new business opportunities and enable the emergence of new business and sustainability models based on Open Source.
- Support the community of European top internet innovators, with the capacity to set the course of the Internet evolution according to a human-centric approach.

Scope:

The aim of this topic is to foster the take up of Next Generation Internet (NGI) technologies and solutions in Europe by integrating them in a variety of industrial and societal use cases, enabling the emergence of internet ecosystems supporting the needs of specific sectors, such as (but not limited to) public services, healthcare and well-being, supply chain management, transport, finance, creative and cultural industries, tourism, energy and ICT sector.

NGI Pilots will make use of the rich portfolio of technologies and tools developed in the NGI programme in Horizon 2020 and Horizon Europe, and will apply them to real-life use cases with the goal of validating NGI human-centric solutions across value chains, as close as possible to operational conditions, engaging large user groups and proving their socio-economic potential. Pilots will also address sustainability beyond the lifecycle of the project.

Pilots will involve user organisations from vertical sectors, NGI innovators and other digital technology providers. Projects will need to carefully consider the needs and expectations of the end-users as main drivers of the technological developments.

Pilots will include development, integration, testing, deployment, uptake and operation activities. Focus will be on open source solutions (both software and hardware) and their integration and adoption in vertical use cases, to ensure replicability of the results and portability in different areas. Proposals should address use cases from at least two different verticals.

Proposals should encourage, when relevant, open access to data, standardisation activities, as well as an IPR regime ensuring lasting impact and reusability of results.

Proposals should incorporate third party contributions from NGI open source innovators. A minimum of 15% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The Commission considers that proposals with an overall duration of typically 24 to 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties will be funded through projects typically in the EUR 10 000 to 50 000 range per project, with indicative duration of 6 to 9 months.

HORIZON-CL4-2023-HUMAN-01-13: Building strong international partnerships and promoting NGI solutions globally (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Supporting the EU internet policy objectives by sharing the EU vision and values with international partners, and forging bonds through concrete collaborations.
- An international ecosystem of top researchers, open source developers, high-tech startups / SMEs and Internet related communities collaborating on the evolution of the Internet according to a human-centric approach.
- Enhanced EU-US and EU-Canada cooperation in the development of Next Generation Internet technologies, services and standards.

- Generate new business opportunities for European Internet innovators based on decentralised technologies and open source.

Scope:

The international actions will focus on reinforcing the transatlantic partnership with the US and Canada, and promoting NGI solutions globally, with a focus on EU neighbourhood and Africa. These actions will deepen the current R&I collaboration with the US and Canada while extending it to other countries / regions.

The regions that will be finally addressed in this topic, its scope and the implementation details, are under discussion with our international partners and will be provided in the next versions of the WP.

6.3 eXtended Reality (XR)

HORIZON-CL4-2023-HUMAN-01-21: Next Generation eXtended Reality (RIA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Next generation of XR devices and applications, by exploiting cross fertilisation between technologies such as 5G/6G, data, artificial intelligence, edge and cloud computing, microelectronics but also across domains of use (education, manufacturing, health, cultural heritage, etc.).
- More realistic and more affordable devices and applications, developed by European companies, respecting European values of ethics, privacy, security and safety, aiming at technological sovereignty.

Scope:

The following two types of research and innovation proposals are expected:

i. The development and integration of advanced XR hardware components, such as displays, optics and sensors, for a new generation of XR devices providing greater visual, wearable, vestibular and social comfort. Special relevance should be given (a) to technological breakthroughs in photonics and new materials aiming to increase the image quality and to reduce the size and weight of XR devices; (b) to displays and optical elements bringing the capabilities of XR devices closer to those of the human vision; (c) to more efficient architectures for enhanced performance, reduced power consumption and improved heat dissipation; (d) to novel systems that cater to the widest range of users, including those that need prescription correction; (e) to advanced optical- and photo-detector technologies for sensing systems, including sensing data processing; and (f) to novel materials with tailored optical, mechanical

and processing properties for a tight integration of subcomponents, enabling overall miniaturization and environmentally sustainable mass-production of future XR devices.

At least one proposal of this type will be funded.

ii. The development of new solutions aiming to improve the user experience in social and professional XR setups. This includes tools and services for the creation and management of interactive virtual worlds and 3D models, realistic avatars and intelligent agents. The solutions will also seek to enhance the interoperability, performance and accessibility of XR experiences. The proposals will include prototypes validated in realistic scenarios, proving how innovative the developed solutions are, how they exploit synergies between disciplines and domains, and how far beyond state of the art they go.

At least one proposal of this type will be funded.

HORIZON-CL4-2023-HUMAN-01-22: eXtended Reality for Industry 5.0 (IA)

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Develop "XR made in Europe", contributing to technological sovereignty.
- Contribute to develop virtual worlds European platforms.
- Support the use of XR technologies for a sustainable, human-centric and resilient European industry[52].
-

Scope: The following two types of innovation proposals are expected.

- i. The development of XR applications to support companies in all industrial ecosystems, especially SMEs, to use innovative interactive and immersive technologies, increasing their competiveness, productivity and efficiency. The applications should be robust, safe and trustworthy, especially in terms of cybersecurity, privacy and health issues. Proposals should exploit cross fertilisation between academics, industry representatives and end-users around well thought-out scenarios. Moreover, proposals should include activities to showcase the results, widely disseminating and exploiting the outcomes.

[52] The term industry in this context encompasses all ecosystems defined in the European industrial strategy

- ii. Develop and prototype advanced interoperable XR solutions to solve common challenges encountered by the industry (in areas such as assembly, maintenance, training, design, logistics, etc.) placing the wellbeing of workers at the centre of the production process. The project should contribute to the development a European platform providing services to the industry through virtual worlds. Involvement of end-users is essential in defining specifications and testing. The funded third party projects should explore a wide range of XR technologies, taking also benefit of other emerging technologies and standards (such as 6G, Artificial Intelligence, edge and cloud computing, microelectronics). The solutions should aim to cover as many industry ecosystems as possible.
-

At least one proposal will be funded for the innovation type I (Max Contribution of EUR X million).

One proposal will be funded for type ii (Max Contribution of EUR X million).

Financial support to third parties

For grants awarded under the type ii Innovation actions, beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants. Each IA for type ii will support third party projects from outstanding XR innovators, SMEs and other multidisciplinary actors, so that multiple third parties will be funded in collectively contributing to the innovation area. The consortium will provide the programme logic and vision for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain. These tasks cannot be implemented using the budget earmarked for the financial support to third parties. Beneficiaries should make explicit the intervention logic for the area, their capacity to attract relevant top talents, to deliver a solid value-adding services to the third-party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently. As support and mobilising of XR innovators is key to the type ii IA of this topic, a minimum of 60% of the total requested EU contribution should be allocated to financial support to the third parties. The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties in type ii will be funded through projects typically in the EUR 250 000 to 500 000 range per project, with indicative duration of 12 to 15 months.

6.4 Systemic approaches for accelerating uptake of technology and innovation

HORIZON-CL4-2023-HUMAN-01-31: Toolbox for efficient IP licensing for market uptake and societal value creation (CSA)

Expected Outcome: Proposals are expected to contribute to the following outcomes:

- Promote effective use and deployment of intellectual property ensuring easier access to and sharing of IP-protected assets.
- Provide models to improve the preparedness to respond to future emergencies via efficient technology licensing.

Scope: Technology transfer, rapid sharing and access to knowledge assets are playing major role in the global Covid-19 response. The uptake of new technology transfer practices, increased role of the various intermediaries and several novel intellectual property (IP) related access initiatives, such as socially responsible and impact licencing models have demonstrated that knowledge and intellectual asset management is a key tool to address the demanding societal needs related to the pandemic.

Robust R&I leads to scientific progress and enables the ecosystem delivering solutions for the society. IP and use of different types of collaboration contracts, licenses and pooling agreements are key elements of the process by facilitating technology sharing, increasing scaling up and thereby creating new capacities and industries.

In line with the EU IP action plan and the Report on an intellectual property action plan to support EU's recovery and resilience by the European Parliament[53], this action will promote better IP management in research and innovation in view to materialise excellent research into innovation that is benefitting the society and businesses in the EU.

This activity will deliver an IP toolbox for helping companies, public research organisations including universities and the relevant intermediary entities to establish quick and efficient co-operation and licences with businesses, as well as practical examples of incentives which can motivate private sector to commit voluntary licensing for other areas e.g. climate change emergency.

This action will harvest the lessons learned as well as practical experiences and assess how these new practices and tools could be transferred to other emergencies e.g. addressing climate change effects (floods, droughts, fires etc). and helping the society to increase preparedness for any future emergencies.

[53] A9-0284/2021

HORIZON-CL4-2023-HUMAN-01-32: Piloting communities of expert facilitators to improve industry-academia co-creation (CSA)

Expected Outcome: Proposals are expected to contribute to the following outcomes:

- Strengthen the base for industry-academia collaboration in the higher education institutions in Europe and help fostering skills addressing industry's needs.
- Facilitate industry and SMEs to capitalise on the diversity of R&I talents, skills and cultures across the EU and spread novel approaches for industry-academia co-creation in cross-border manner.
- Boosting valorisation of excellent research results and innovation, i.e. transforming them into sustainable solutions with economic and social value across the Union.

Scope: There is a clear need to improve industry-academia interactions in Europe[54] and enhance knowledge valorisation[55] in innovation ecosystems. Methodologies for improved industry-academia co-creation through expert facilitation offer possibilities for higher education institutions to better meet the needs for innovation from the industry and business side. The diverse pool of R&I talents at the higher education institutions across the EU constitutes a vast source for creativity which should be fully capitalised for innovation.[56]

This action will pilot communities of expert facilitators for increasing knowledge exchange and co-creation between industry and academia and help matching the supply and demand for innovation. This action will link professionals in industry-academia collaboration, build communities of expert facilitators for industry-academia co-creation and disseminate best practices and know-how for demand-driven industry-academia collaboration across Europe. This will include training a wider community of expert facilitators in higher education institutions across Europe.

HORIZON-CL4-2023-HUMAN-01-33: Towards systemic transformations through societal and cultural interactions for knowledge valorisation (CSA)

Expected Outcomes:

Projects are expected to contribute to the following outcomes:

[54] Council conclusions on "Accelerating knowledge circulation in the EU" adopted on 29 May 2018; SRIP Report - Science, Research and Innovation Performance of the EU 2020.
[55] Council Recommendation (EU) 2021/2122 of 26 November 2021 on a Pact for Research and Innovation in Europe (ST/13701/2021/INIT)
[56] Policy Report "Towards a 2030 Vision on the Future of Universities in Europe" https://ec.europa.eu/info/publications/towards-2030-vision-future-universities-field-ri-europe_en

- Value creation and transfer to economy and society by increased interactions between arts and cultural institutions, citizens and industry

- Innovative solutions with strong societal acceptance for uptake and transformative capacity through new conceptualisations of societal challenges enabled through artistic methodologies and approaches

- Enabling interactions, schemes and modes engaging society, arts, cultural institutions and industry to benefit communities and promote recovery and the twin transition

Scope: The new Industrial Strategy targets place-based innovation with broad stakeholder engagement. The European knowledge valorisation policy places much attention on a more diverse societal engagement involving a multitude of actors in order to create value through innovation benefiting all of society.

Enabling systemic change and achieving the twin transition cannot be achieved by technological solutions alone, if these solutions are not accepted and fully used by society. Engagement with the arts and cultural institutions can increase citizens' understanding of complex issues (such as climate change, data, artificial intelligence etc) and involve citizens in co-creation for solutions drawing on existing knowledge and research results and driven by art and technology. Strengthening approaches of experimentation and creativity common in the ways artistic and cultural interactions operate, in co-creation with citizens and industry, can increase the potential for transformation towards a more prosperous, inclusive and innovative future.

This action aims to strengthen and further develop existing or new schemes promoting arts-industrial technologies-citizens interactions, that increase uptake of new technologies and innovative solutions through better societal understanding and acceptance, as well as co-creation delivering economic and societal benefits. While arts and technology are the main drivers, citizens and communities are empowered to develop, test, co-create and share the benefits of new innovative solutions that address their needs. Industry is stimulated to adopt more human-centred and creative approaches, enhanced by interactions with citizens, artists, designers, cultural and creative professionals and institutions.

The proposals will address at least one of the following challenges:

- Developing and testing new schemes, initiatives and modes for arts-industrial technologies-citizens interactions leading to increased uptake of research results and innovative solutions by market and society. At least 20 new schemes and initiatives across Europe will be tested;
- Transferring, with the appropriate adaptations, and testing in another environment, existing schemes, initiatives and modes for arts-industrial technologies-citizens interactions that increase uptake of research results and innovative solutions by market and society. At least 20 existing (or recent) schemes and initiatives will be tested in a different member state to where they are in place/ originate, across Europe.

6.5 Research and Innovation for Industry 5.0

HORIZON-CL4-2023-HUMAN-01-51: Pilots for an innovative human-centric industry (RIA)

Expected Outcome:

Project results are expected to contribute to the following outcomes:

- Improved understanding of the socio-technical and ethical implications of advanced (digital) technologies for workers and work organisation across industrial sectors;

- Work environments and work models that make best use of the possibilities of advanced (digital) technologies and the human capabilities and creative potential in a synergistic manner, thus contributing to enhanced European industrial competitiveness in existing and new markets;

- A skilled and creative industry workforce that is empowered through and in control of advanced technologies that are aligned with European social and ethical values.

Scope:

Digitalisation and automation in industry to date have focussed primarily on capitalising on opportunities to increase efficiency and enhance productivity, often without much attention to the changing role of the worker. In its Industry 5.0 concept , the Commission puts forward a view of a resilient, sustainable and human-centric industry. The human-centric approach implies placing core human needs and interests at the heart of processes in industry, rather than taking the technology and its potential for increasing efficiency as a starting point.

A human-centric industry recognises and leverages the capabilities and creative potential of its workers through the synergistic combination with advanced (digital) technologies. In this process, with regard to work organisation, work content and skills, working conditions and work relations, fundamental principles and human needs such as human autonomy and control, coherence and variation of tasks, work-life balance, social dialogue and others, must be safeguarded, as well as human rights such as privacy and safety. Moreover, as diverse groups of workers experience the increasing impact – as well as opportunities - of the digital transition, upskilling or reskilling is required to meet the digital transformation challenges of the enterprise.

The projects will develop and demonstrate the concept of human-centricity in a real-life, operational industrial environment in at least two pilots each, in different

industrial sectors in different EU Member States or countries associated to the Horizon Europe programme. This will require innovating and going beyond-the-state-of-the-art with respect to technology and/or its purposeful application, achieving a Technology Readiness Level (TRL) of at least 7. In addition and as appropriate, innovation is expected with respect to work organisation, tasks and functions of workers, skills and training, occupational health and safety, enterprise management and governance (incl. the management of human resources), business models, corporate values and ethics, etc.

In addition, the pilots may address particular themes such as the ones listed hereunder in a non-prescriptive and non-exhaustive manner: the development of and experimentation with models and technologies to stimulate individual and collective creativity of workers, the participation of workers (as end-users) in the design of purposeful technology application in the work process, the application of technology to enhance the inclusivity of the work environment, the ways in which unskilled or low-skilled labour participate in a human-centric production process and the role of technology therein, etc.

The projects will report the obtained results and the practices leading to success, as well as the encountered difficulties and bottlenecks and any trade-off that had to be made. They will identify and analyse direct and indirect effects and outcomes of the pilots, including not only those that pertain to workers' satisfaction and well-being, but also those that implicate the competitiveness and resilience of the company and, taking a wider perspective, the societal role of industry as responsible provider of prosperity. The consortia will interpret all this in a coherent theoretical framework, taking into account the specificities of the setting and context of the pilots. They will formulate evidence-based recommendations tailored to relevant stakeholders, including, as appropriate, policy makers at relevant levels (EU, national/regional, sectoral), social partners, industry federations and professional associations and organised civil society (NGOs).

This topic requires an interdisciplinary approach with the effective contribution of SSH disciplines and the involvement of SSH experts and/or institutions.

The proposals will devote attention to the gender dimension in the content of the proposed research and innovation, in order to deliver scientific quality and societal relevance of the produced knowledge and innovation.

Project proposers should consider and actively seek synergies with relevant active and finalised projects in the Horizon 2020, Horizon Europe and Digital Europe programmes.

HORIZON-CL4-2023-HUMAN-01-52: Drivers and success factors for progress towards Industry 5.0 (CSA)

Expected Outcome:

Project results are expected to contribute to the following outcomes:

- Increased uptake of the Industry 5.0 principles and practices across industrial sectors, achieved through improved understanding of its benefits for enterprises and society and actionable knowledge about factors of success and impediment;

- Sound data and analysis of the uptake of Industry 5.0 in its different dimensions for policy makers at EU, national/regional and sectoral level.

Scope:

In January 2021, the Commission articulated, under the name Industry 5.0 , a vision of a future-proof industry that, capitalising on technological progress beyond productivity and efficiency, is the resilient provider of prosperity, within planetary boundaries and placing the wellbeing of the worker at the centre.

In order to optimise policies that stimulate the uptake of the Industry 5.0 principles of sustainability, resilience and human-centricity and facilitate their implementation, an increased understanding of drivers and factors contributing to or hindering successful implementation is required.

The action will select and thoroughly study the successful or less successful implementation of the Industry 5.0 principles in at least five cases in different EU Member States or countries associated to the Horizon Europe programme. This may be complemented with other cases. If a case in a country outside the EU or in a country not associated to the Horizon Europe programme would be proposed, its relevance must be demonstrated in the proposal. The overall design of the study must be well deliberated, founded in a coherent theoretical framework, and provide for a careful selection of cases (for instance, by variation of relevant case characteristics such as company size, industrial sector, country typology, etc.) and for a framework of analysis that can be applied consistently across cases. The smart study design should enable the consortium to extract maximal and relevant insights from the combined analysis of the selected cases.

Taking into account and exploiting the specificities of the cases, the deep analysis of the individual cases, together with the combined analysis of the cases, will address the following research themes in an evidence-based manner.

- Implementation practices: How do companies, local innovation ecosystems or industry sectors implement Industry 5.0 principles in practice? Which modes of implementation exist? How does industry go beyond the state-of-the-art and innovate, for instance with respect to (the purposeful application of) technology, work

organisation and production, organisation and operation of supply chains, worker tasks and functions, training and skills, human resources management, business models and value chains, corporate governance, partnerships and networks, etc.?

- Drivers: What are the drivers for companies, industry sectors or industrial ecosystems to adapt (or not) Industry 5.0 principles? Which role do public policies and regulatory environment play? How does successful implementation of Industry 5.0 principles provide advantage to companies? Which trade-offs may have to be made?

- Success factors and bottlenecks: What are the factors, either internal or external to the company, that contribute or hinder the uptake and implementation of Industry 5.0 principles?

- SMEs: How can/do SMEs take up Industry 5.0 principles and what is the role of the local innovation ecosystem in this? How does it help SME's to participate successfully in the green and digital transition of industry?

Proposers are encouraged to elaborate the above research themes further with a view to contributing fully to the expected outcomes. Proposers will explain and motivate the trade-off made between number and representativity of study cases and breadth and depth of analysis.

The analysis must go beyond mere desk research and must be developed and validated in interaction with the actors involved in the respective cases.

Projects will transfer knowledge in actionable form to relevant actors including policy makers, social partners and industry federations, organised civil society (NGOs).

In addition, the action will develop, test and validate a methodology that measures (quantitatively) and evaluates (qualitatively) the progress towards Industry 5.0 in its three dimensions of resilience, sustainability and human-centricity and develop indicator sets that are applicable respectively at the scale of an industrial sector and across sectors, allowing monitoring at relevant levels (EU, national/regional, sectoral).

Project proposers should consider and actively seek synergies with relevant active and finalised projects in the Horizon 2020, Horizon Europe and Digital Europe programmes.

6.6 European standards for industrial competitiveness

HORIZON-CL4-2023-HUMAN-01-61: Facilitate the engagement in global ICT standardisation development (CSA)

Expected Outcome: Provide training, share information about global sectorial ICT standardisation ecosystems and engagement of European stakeholders in global standardisation settings.

Projects are expected to contribute to the following outcomes:

- Set-up of a facility to support participation of European specialists in international ICT Standard Developing Organisations (SDOs) and global fora and consortia, which should increase the influence of Europe into ICT standardisation, including representation in leadership and key positions, to promote incorporation of European requirements, values and interests in ICT standardisation;
- Develop and update sectorial ICT standardisation landscape analysis and gap analysis of ICT standardisation needs in support of EU policies as outlined in the Rolling Plan for ICT standardisation;
- Cooperate, synchronise and achieve synergies with other similar initiatives or European players including from EU (and national) funded R&I projects; provide a forum for foresight analysis in different sectors;
- Increase awareness and education & training on ICT standardisation development;
- Support standardisation meetings in Europe of international SDOs and global fora and consortia, so that European players have easier conditions for participation.

Scope: This action will contribute to the objectives spelled out in the EU Standardisation Strategy[57], in particular to **supporting the EU's leading position in global standards-setting as a forerunner in key technologies and promoting EU core values,** by supporting and empowering the participation of European stakeholders in the development of open technical specifications and standards with the aim to strengthen European competitiveness and sovereignty, promoting European values and ethics, and strengthen the take-up, scalability and cross-sector interoperability of their technological solutions.

The aim is to reinforce the presence of EU and associated states experts in the global ICT standardisation scene, by setting up an ICT standardisation observatory and a facility supporting the participation of key European specialists (especially from SMEs and Academia) in key international and global Standard Developing Organisations[58].

[57] Ref.

[58] Such us ISO, IEC, ISO/IEC JTC1, ITU-T, 3GPP, IETF, OneM2M, W3C, OASIS, IEEE (list non eshaustive)

The action will also contribute to the objective of promoting EU cutting-edge innovation that fosters timely standards, by coordinating with other EU funded projects and action that may contribute with their results to ICT standardisation, as well as with EU supported PPPs and Joint Undertakings, seeking for synergies.

It is also expected that the action will contribute to the objective of improving education and skills of European experts on ICT standardisation.

To achieve these objectives, key tasks to be carried out are:

- Mapping of the relevant activities in international ICT standardisation, including identification of sectors and areas, in particular within the field of internet standardisation.
- Setting up of a management facility to support contributions and leadership (e.g. chairing of technical committees, convenor positions) of European specialists (incl. from SMEs and academia) in global ICT SDOs, fora and consortia. Financial support for these specialists will be typically in the order of EUR 1.000 – 10.000 per action by use financial support to third parties (FSTP). 70% of the call budget is expected to be dedicated to FSTP and the maximum cumulated amount of FSTP is EUR 50.000 per third party for the entire duration of the action.
- The consortium will define the process of selection of experts through open calls. It will also define the process that will lead to a selection of a pool of evaluators that will evaluate the applications received in the open calls through the use of FSTP.
- When relevant, hosting standardisation meetings and workshops in Europe to ease the participation of European experts;
- Facilitate a foresight Committee, which liaise with relevant on-going developments in EU and national funded R&I projects, in particular with projects having identified standardisation outputs or with potential relevant results to contribute to standardisation, including as well other coordination and support actions, and relevant European Partnerships;
- Promotion of the relevance and benefits of ICT standardisation, especially for European industry competitiveness, driving sustainability, sovereignty, green deal, values and ethics. The proposal will also include actions, including development of tools and materials, to promote education on ICT standardisation;
- The proposal should take into account the previous activities carried out the observatory and facilities for funding experts within the topics ICT-40-2017 implemented by the StandICT.eu project and ICT-45-2020 implemented under StandICT.eu2023 project (see http://www.standict.eu).

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

Cross-cutting Priorities:Societal Engagement, Innovation Procurement

HORIZON-CL4-2023-HUMAN-01-62: Fostering standardisation to boost urban industrial symbiosis (CSA)

Expected Outcome: Proposals are expected to contribute to the following outcomes:

- Reinforcing the links between standardisation and circular value chains related research and innovation ensuring that standardisation facilitates interoperability between stakeholders and actors at all level.
- Facilitating the entry to market of innovative solutions, which could facilitate the circularity of resources and zero pollution.
- Promoting enabling framework conditions for standardisation as an important enabler for industrial symbioses.
- Helping in the development of agile standards by identifying the major bottlenecks of interoperability in the domain of industrial symbioses.

Scope: As emphasised in the European Green Deal and in the New Industrial Strategy for Europe, developing new standards, coupled with increased EU participation in international standardisation bodies, will be essential to boost industry's competitiveness and build a sustainable and more inclusive future.

This action will identify solutions on how standardisation can allow stakeholders at all level to develop a shared understanding for processes by which wastes or by-products of an industry or industrial process become the raw materials for another.

The action will cover manufacturing in a wider context taking into consideration waste treatment and management, energy use and materials sourcing. It will evaluate the impact of industrial symbiosis on environment and strengthen the link between environmental science and policymaking. In this multidisciplinary approach standards have a key role as they reduce the multiplicity of approaches, terminologies, measurements allowing for accurate benchmarking and target setting.

The selected project may benefit from being addressed by a consortium that include, inter alia, a variety of stakeholders covering industry, energy and environment.

HORIZON-CL4-2023-HUMAN-01-63: Provide for a strong and sustainable pool of experts for European Standardisation: attract the students of university/HEI

Expected Outcome: Inclusion of standardization knowledge in university/HEI curricula to win students, the professionals of tomorrow, to contribute to standardization: strong and sustainable pool of European experts ready to engage in regional, European and International Standardisation

Projects should support to the following outcomes

- More standardisation-competent university/HE students ready to contribute to European standardisation
- More curricula of universities/Higher Education integrating standardisation contents covering the technological, innovations-supportive and societal aspects (EU values)
- Design of a European Teaching Concept covering both, the traditional (engineering) and the all-pervasive ICT standardisation, and facilitating personal and distant teaching
- Increased visibility of standardisation at universities/HEI through "Academic Standardisation Days" and setting-up of a Students' Standardisation Association

Scope: "European Green Deal" and "New Industrial Strategy for Europe" and the geopolitical environment call for a strong EU presence in international standardisation development.

This action aims at providing a robust pool of experts. University/HE teaching can help providing for tomorrow's experts, well-educated and ready to make Europe's voice heard in international standardisation; the mission is innovation-spurring standards fully coherent with EU core values!

The teachers in EU universities/HEI who already integrate standardisation-related contents in their lectures, should in co-operation with industry, design an innovative standardisation-related teaching. This concept should cover the standardisation under IEC, ISO and ITU lead, update students on the highly decentralised, global ICT-related standardisation and address the technical and societal facets of standardisation (multidisciplinary orientation). The teaching concept has the mission to bridge between these two standardisation domains as well as integrate the aspects of a human-centric standardisation and the EU basic values. Where applicable, the standardisation teaching contents should foster the development of green and digital skills.

Based on this concept, direct and distant teaching modules should be developed. These teaching concepts should be shared with universities/HEI ready to include standardisation-content in their teaching offer.

Promotion actions should increase the visibility of standardisation in EU academia/HE. "Academic Standardisation Days" at EU universities/HEI and the "Students' Standardisation Association" should be part of the actions to be developed.

HORIZON-CL4-2023-HUMAN-01-64: Pre-normative standardisation and research in industrial ecosystems (CSA)

Expected Outcome:

The action is expected to contribute to the following outcomes:

- Contribute to the achievement of the European industrial policy objectives, especially in relation to the green and digital transitions (twin transitions) and the circular economy.
- Bring together the research world (projects, universities, innovation centres, etc.) with the supply chains and the stakeholders within each industrial ecosystem in order to define standardisation needs and priorities, the role to be played by pre-normative research, the contributions to be provided at the European and international standardisation level.
- Define roadmaps for pre-standardisation activities in emerging domains not yet covered by ongoing work.
- Establish a platform for the deployment of education and training in standardisation in the framework of the identified industrial sectors.

Scope:

The first Annual Single Market Report [SWD(2021) 351 of 5/5/2021] identifies the following industrial ecosystems: 1. Aerospace & Defence, 2. Agri-food, 3. Construction, 4. Cultural and Creative Industries, 5. Digital, 6. Electronics, 7. Energy Intensive Industries, 8. Energy-Renewables, 9. Health, 10. Mobility-Transport-Automotive, 11. Proximity, Social Economy and Civil Security, 12. Retail, 13. Textiles, 14. Tourism. Tourism. Further ecosystems or cross-cutting themes (such as chemicals and materials) may be identified and their delineation adapted based on stakeholders dialogues and changing realities.

The Report analyses their different needs and challenges. In particular, the Report assesses the relevance of standardisation in each ecosystem and proposes specific actions in order to overcome existing barriers to the Single Market.

The action should cover the coordination/execution of pre-normative standardisation activities in the various ecosystems with a view to exploit synergies among the stakeholders. The scope is to boost the interactions between research projects and pre-normative work in the various ecosystems, and to increase the European contribution and presence in the subsequent formal European and international standardisation processes in line with the objectives of the forthcoming standardisation strategy to be adopted by the Commission at the beginning of February 2022. Interoperability standards for data sharing within and across the ecosystems should be addressed.

Additionally, a strategy for education and skills development within the ecosystems should be developed, associating social partners when relevant.

The action should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. International cooperation is encouraged, especially with the international standardisation organisations ISO, IEC and ITU, and similar organisations such as OECD.

Note: The ideas of topics below seem to display synergetic potential for joint approaches with sectorial clusters. Discussions are starting to explore the feasibility and relevance of joined work. At this stage, the current elements are still presented below for awareness and early feedback but may evolve according to cross-cluster discussions.

6.7 Alternative and decentralised social economy platforms

6.8 Contributions to New European Bauhaus

HORIZON-CL4-2023-HUMAN-01-NN: Human compatible and ecologically conscious: artistic experimentation with digital technology in support of 'New European Bauhaus'

Expected Outcome:

It is expected that the projects will lead to a mind change in EC funding regarding the role of the arts in R&I following the spirt of the '*New European Bauhaus'*.

1. Artistic experimentation in R&I is expected to accelerate development and novel uses of ecologically conscious and human compatible technologies. Examples include in particular:

- Art-driven use of digital in urbanism to create sustainable carbon-neutral cities
- Art-driven use of digital to fight disinformation and change social behavior in context of climate change.
- Art-driven development and use of AI in spirit of EC communication on '*trustworthy AI'*.

2. Promote synergies between art and technology via an annual prize and festival.

   a. Continue the well-established annual STARTS prize that honors successful collaboration of artists with technologist, organise annual calls and awards and disseminate the prizes and its winners via an exhibition. Following earlier editions, prizes will be awarded in two categories aligned to the '*New European Bauhaus'*.

   b. Enhance outreach via an annual STARTS Festival that will allow reflecting on relation of AI with its human users and on role of digital in sustainability. Performances in music

and other forms of artistic expression and exhibition of results from artistic experimentations will contribute to a better understanding of human compatible and ecologically conscious digital technologies and their role for the '*New European Bauhaus'*.

It is expected to fund one CSA focussing on 2(a) and one CSA on 2(b). Proposers should choose one and clearly indicate to which of the two they will contribute.

Scope:

While Europe is strongly pushing innovation based on technological and scientific progress, it has always put social and ecological priorities on the same level as economic growth. Europe emphasizes the need for constructive critical thinking on technology impact on the environment, on us as individuals and on society. This has led to a new alliance of the arts with S&T as part of a European innovation policy rooted in values and culture. Artists critically reflect on, tinker with, push limits of technology. They become key drivers towards ecologically conscious and human compatible technologies, that are aware of sustainability challenges and contribute to the twin transition and that are driven by human values and priorities. In this spirit, DG CONNECT has launched in 2016 S+T+ARTS - innovation at the nexus of Science, Technology and the ARTS – and the European Commission president has proposed the '*New European Bauhaus'* where the arts are a main player in achieving the twin transition.

In support of '*New European Bauhaus'* ambition, the CSAs will encourage actors in R&I (in Horizon Europe and Digital Europe and beyond) to adopt artistic experimentation as a complementary method of technology development and use. More specifically, the CSAs will finance, stimulate, facilitate, and mentor artistic experimentation via STARTS residencies of artists in technology institutions, SMEs and/or EC funded projects.

Further tasks of the CSAs comprise implementing best practices for including artists in R&I activities, disseminating results from art-technology collaborations via an annual prize, an annual festival, and in exhibitions that are highly visible in industry and in the art world. They will coordinate contributions of the STARTS program to the '*New European Bauhaus'*.

Financial support to third parties:

CSAs will hand out grants for STARTS residencies via third party funding in the form of grants to artists (maximum EUR 40 000 per artist, in total a minimum of 1.6MEUR). They will hand out two annual prizes of EUR 20 000 each via third party funding in the form of prizes (in total 120000 EUR).

The Commission considers a duration of 36 months as appropriate.

OTHER ACTIONS NOT SUBJECT TO CALLS FOR PROPOSALS

Grants to identified beneficiaries

1. HORIZON-CL4-NGI-01-SGA - Developing the first stage of Next Generation Internet commons (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic "HORIZON-CL4-2023-HUMAN-01-NN: Framework Partnership Agreement for the Next Generation Internet commons", the selected consortium will be invited to submit a proposal that will implement the first 3 years of the above FPA and covering its full scope.

Expected Outcome: Projects are expected to contribute to the following outcomes:

- The SGA should contribute to a flourishing internet, based on common building blocks created within NGI, that enables better control of our digital life, respects our privacy, permits better sharing of data (including personal and non-personal) based on users' preferences, and enables better socio-economic impact based on improved trust.
- A mobilisation of at least 1000 innovators driving the evolution of a human centric internet
- At the end of the SGA, a minimum of 4 strategic projects achieving autonomy for example by reaching legal establishment status, bringing in non-Horizon Europe source of funding or having a critical mass of innovators contributing to it.
- Synergies with NGI pilots as well as with other relevant actions in Europe and outside.

Scope:

Proposers should setup a continuous open call environment addressing open source communities and implementing the requirements for financial support for third parties in terms of transparency, publicity, confidentiality, fair treatment, and handling of conflict of interest.

The calls should explore the full internet stack (both server and devices) from open hardware to applications with the aim of shaping Internet commons with improved trust, privacy, portability, discoverability, inclusion with better sharing and search of personal and non-personal data with advanced identity management, implementing optimal balance between decentralisation, security and energy efficiency and ensuring more socio-economic benefits.

Proposers should strive for identification of common tools and stimulate maximum re-use among funded projects e.g. interoperable identity and credential management tools, common packaging solutions, tools for decentralised social media, when relevant.

Proposers should publicise calls towards the open source communities actively influencing the course of the Internet commons.

Proposers should detail the services that would be offered for maturing third parties projects including security and accessibility audits, packaging of the software for easy deployment, localisation of the software in EU languages, documentation best practices and advising on licensing.

The path to growth should detail how projects will gain critical mass, what services will be provided when reaching such stage, what governance models can be advised, what strategy for standardisation, what funding models for sustainability.

Proposers should actively manage the portfolio of funded projects and provide a coherent overall picture, describing how mature the solution is by giving details on audits made and ensuring trusted and easy deployment capabilities for each building blocks.

The governance model of the project should detail how the EU policies can be translated into call for action e.g. in relation to European strategic autonomy and the maintenance strategy for the future commons.

Proposers should create the conditions for successful collaboration with NGI pilot actions as well as other ongoing NGI actions such as the outreach office and actions in the area of trust, search and international.

Proposers should seek active collaborations with other funding efforts addressing internet commons at European and national levels and beyond Europe.

Critical Raw Materials Exploration Investment Facility with the European Bank for Reconstruction and Development (EBRD)

Description:
The EU green and digital transitions will continuously increase the demand for raw materials. As far as the development of technologies and markets for secondary raw materials will increase, covering some of the demand, primary raw materials will remain an important source of raw materials.

Europe is rich in resources that should be explored and analysed in the context for potential future uptake by investment projects. Novel, innovative technologies for exploration are being funded through EU programmes. However, the next barrier is their utilisation. Mineral exploration activities requires high investments which are associated with high financial risk, due to the uncertainty of the final outcome. . As a consequence, a sub-optimal amount of resources are invested in exploration activities.

In order to support the sustainable supply of raw materials , the European Commission and the EBRD seek to pilot a financial instrument to provide access to finance, in the form of equity or quasi-equity, to companies performing sustainable exploration in Europe through novel technologies. The facility can also target investment cases aiming at exploiting the technologies developed with the support of EU Framework Programmes for Research and Innovation.

This activity will contribute to the implementation of the following action from the Critical Raw Materials Action Plan, COM(2020) 474:
Action 5 - Identify mining and processing projects and investment needs and related financing opportunities for critical raw materials in the EU that can be operational by 2025, with priority for coal-mining regions (Commission, Member States, regions, stakeholders);

Further details regarding the underlying financial structure, including the risk-sharing arrangement between the Commission and the EBRD, the allocation of annual commitment and eligibility rules related to blending operations will be specified in the Guarantee Agreement (or in an amendment to it) signed under InvestEU.

This action directly aimed at supporting the development and implementation of evidence base for R&I policies and supporting various groups of stakeholders is excluded from the delegation to the Executive Agencies and will be implemented by the Commission services.

Type of Action: Financial Instrument
Indicative timetable: XXX
Indicative budget: EUR XXX million from the 2023-2024 budget

UNECE resource management system

UNECE-EGRM Secretariat The United Nations Economic Commission for Europe (UNECE) is one of the five regional commissions of the United Nations. Its Expert Group on Resource Management (EGRM) has developed the United Nations Framework Classification for Resources (UNFC), an UNendorsed, universally accepted and internationally applicable classification scheme for energy and mineral resources. The EGRM is developing

classifications for other resources (solar, geothermal, hydro, wind and bio-energy resources, anthropogenic resources). EGRM is building on that framework to develop a dynamic system for sustainable management of resources (United Nations Resource Management System, or UNRMS).

The Commission will contribute on behalf of the EU to the UNECE-EGRM secretariat to further develop a unified, comparable, interoperable and harmonised system for resource assessment usable for governmental, statistical, corporate and financial purposes; to support the capacity and knowledge foundations for UNFC and UNRMS; to communicate the activities, deliverables and findings of the EGRM, including policy tools; and to synthesize, review, assess and critically evaluate relevant information and knowledge on resource management. The financial contribution will support, inter alia, the preparation and dissemination of reports, such as a tool-kit for sustainable management of resources for governments; refining UNFC- and UNRMS-based reporting codes and application guidelines; the preparation of case studies and application examples at country and corporate levels; high-level consultations with investment banks, development banks and other financial institutions; engaging experts and facilitate participation of experts from the EU, associated and third countries in this process; facilitate setting up a network of International Centres on sustainable management of resources; coordination with key institutions; communicating about deliverables and findings, conducting multi-stakeholder workshops and training courses; and strengthening the synergies between EU funded actions and UNECE outputs on UNFC and UNRMS. The action will also support the organisation of high-level dissemination events in the EU, targeting policy makers and other relevant stakeholders, in order to provide timely, high-quality and policy-relevant information and strengthen the dialogue on resources and the 2030 Agenda for Sustainable Development.

Legal entities: UNECE, Palais des Nations, CH-1211 Geneva 10, Switzerland
Type of Action: Contribution agreement with an implementing entity (indirect management)
Indicative timetable: 2024 Indicative budget: EUR XXX million from the 2024 budget

JRC Support to the Action Plan on Critical Raw Materials

Objective: To continue the collaboration with the JRC on various aspects of raw materials policy, such as raw materials for industrial ecosystems, framework conditions and potential supply of primary raw materials.
Duration: 24 months
Form of Funding: Direct action grants
Type of Action: Provision of technical/scientific services by the Joint Research Centre
Indicative timetable: Q1 2024
Indicative budget: EUR XXX million from the 2024 budget

Raw Materials events

It is envisaged to procure activities for the organisation of events (conferences, workshops or seminars), including the Raw Materials Week through Framework Contracts before the end of 2023 and 2024.
DG GROW is organising the Raw Materials Week in the fourth calendar quarter of 2023 and 2024, covering set of events including the High Level Conference of the European Innovation Partnership (EIP) on Raw Materials.
Form of Funding: Procurement
Type of Action: Public procurement- Framework contract
Indicative timetable: Q4 2023 and Q4 2024
Indicative budget: EUR XXX million from the 2023 budget and EUR XXX million from the 2024

Support to Hydrogen in the Economy

The Commission represents the European Union in the International Partnership for Hydrogen and Fuel Cells in the Economy. The annual financial contribution will be paid to the entity responsible for managing it.
Type of Action: Subscription action
Indicative timetable: as of 1st quarter 2023, as of 1st quarter 2024
Indicative budget: EUR XXX million from the 2023 budget and EUR XXX million from the 2024 budget

Cross-cutting: International

This section is a placeholder for dimensions under development, such as but not limited to international aspects that may already feature throughout this draft.